INDEX

TO

TRANSACTIONS

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VOLUME 2

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INTRODUCTION

This index of the TRANSACTIONS consists of two separate parts, each intended for a distinct purpose.

First. There is an index of papers in which they are classified in natural groups and arranged chronologically in each group.

Second. There is an index of specific data and information arranged alphabetically.

The index of papers is intended for searchers desiring to locate papers on a given subject, and to aid in this search the papers have been characterized. These characterizations are not intended to be abstracts of the papers, but rather to give the scope and nature of their contents. The titles of many papers are misleading, and it is hoped thus to call the searcher's attention to the real nature of the contents, thus saving him much time in looking up useless references.

The index of specific data and information is intended for searchers desiring to make a complete study of the subject as presented in the TRANSACTIONS. There is a great mass of valuable information hidden in discussions which have no very direct connection with the subject of the paper. This data can be found only by reference to such a topical index.

Methods of classification of engineering information are as numerous as the people who have studied the subject. A logically arranged classification for this index seemed impossible. Accordingly all information was grouped into natural classes and very complete cross indexing was provided. The searcher will thus be lead to the desired information whatever may be his ideas of a proper arrangement.

The classification of the papers was determined by sorting them for the entire period covered by the index. Any group containing a large number of papers was subdivided. All papers were arranged chronologically to enable the searcher to pass over the early papers that might be too old for his use.

Naturally, many papers, especially when considered together with their discussions, fell into a number of different groups. In all such cases they were put into as many places as it was thought they might possibly belong If there was any doubt one way or the other, a paper was always put in.

There is no harm in having a paper under a heading where someone thinks it should not be, so long as it is also under the heading where that person thinks it ought to be. For instance, many high-tension systems ordinarily considered transmission lines, are to all intents and purposes distribution systems. In the future they will undoubtedly be considered

such as we now consider as distribution systems those which some years ago we looked upon as transmission lines. Accordingly, papers dealing with high-tension distribution systems are listed both under transmission and distribution.

The topical index is not a classified index in the ordinary sense. However, all of the information is properly grouped in an alphabetical manner. The conditions it was intended to carry out were as follows:

1. To index all useful specific data and information contained in the TRANSACTIONS.

2. To arrange the index items in such a manner that anybody could find them with a minimum of trouble.

In the attempt to meet these conditions the following general rules were observed:

1. All subjects are indexed under the noun, and where an adjective is practically inseparably associated with a noun by usage, it has been incorporated with it by a hyphen.

2. All references to a given subject are listed in the same place, so that having found one reference the searcher can rest assured that he has found all.

3. Apparatus and phenomena known by several names are grouped under one name and the other names inserted in the index with cross references. For instance, inductance coils, reactance coils, reactive coils, choke coils, reactors will all be found in the index with cross references to Reactors.

4. Apparatus and phenomena common to two or more subjects are grouped by themselves and cross references inserted under the related subjects. Thus, commutation is indexed by itself with cross references under generators, d. c.; motors, a. c.; motors, d. c.

5. Apparatus and phenomena of sufficient importance in themselves are indexed alone with cross references under the main heads of which they form a sub-division. Thus, catenary construction is indexed under catenary construction with cross reference under distribution, railway.

6. All properties of materials and apparatus are indexed under the name of the material or apparatus, except where the references are to the characteristics of the properties themselves. Therefore, a searcher will find under the name of a material all the properties of that material given in the TRANSACTIONS.

7. No distinction is made between singular and plural in arrangement of the items.

An attempt has thus been made to make it impossible for a searcher not to find all the information which is contained in the TRANSACTIONS. Actual use of the index can alone determine the success or failure of this undertaking. But, however unsuccessful in this particular, it is believed that this index will greatly increase the value of the TRANSACTIONS.

1. EDUCATION

PRESIDENTIAL ADDRESS

Charles P. Steinmetz Vol. xix—1902, pp. 1145-1150

Description of the shortcomings in present methods of teaching engineering in colleges. Outline of an ideal course in electrical engineering.

Discussion, incorporated with that of paper by E. B. Raymond on "A Proposed Reform in Technical Training."

CONCERNING UNIFORMITY IN ELECTRICAL ENGINEERING COURSES IN THE UNITED STATES

Samuel Sheldon Vol. xix—1902, pp. 1151-1154

Purpose of engineering schools. Statistics bearing on the uniformity of courses in different colleges, and brief discussion of the kind of training required by engineers.

Discussion, incorporated with that of paper by E. B. Raymond on "A Proposed Reform in Technical Training."

ELECTRICAL ENGINEERING COURSES AT COLLEGE AND THE EDUCATION OF THE ELECTRICAL ENGINEER

William Esty Vol. xix—1902, pp. 1155-1164

General outline of ideal method of instructing engineering students; kind of studies, laboratory method; seminary method; theses, etc.

Discussion, incorporated with that of paper by E. B. Raymond on "A Proposed Reform in Technical Training."

THE EDUCATION OF THE ELECTRICAL ENGINEER

Harold W. Buck Vol. xix—1902, pp. 1165-1168

General outline of a course of training for electrical engineers, beginning with preparatory school, continuing through college and ending with an apprenticeship course.

Discussion, incorporated with that of paper by E. B. Raymond on "A Proposed Reform in Technical Training."

A PROPOSED REFORM IN TECHNICAL TRAINING

Edward B. Raymond Vol. xix—1902, pp. 1169-1173

Plan advocating early entry into studies along a given line, and urging specialization throughout entire educational period.

Discussion (including that of Samuel Sheldon on "Concerning Uniformity on Electrical Engineering Courses in the United States," Presidential Address, by Charles P. Steinmetz, paper by William Esty on "Electrical Engineering Courses at College and the Education of the Electrical Engineer"; and paper by Harold W. Buck on "The Education of the Electrical Engineer"), pp. 1175-1210, by Messrs. Chas. P. Steinmetz, F. A. C. Perrine, E. B. Raymond, Morgan Brooks, William Stanley,

W. E. Goldsborough, C. A. Adams, Jr., C. P. Matthews, Geo. F. Sever, Chas. E. Skinner, and R. W. Pope. General remarks on methods and ideals of electrical engineering education.

THE TEACHING OF PHYSICS TO ENGINEERING STUDENTS

W. S. Franklin Vol. xxii—1903, pp. 561-566

Discussion of certain common faults in teaching methods, followed by a general outline of the author's method.

Discussion, p. 567, by Messrs. W. E. Goldsborough and A. S. Langsdorf.

THE PROBLEMS THAT ARE FACING THE ELECTRICAL ENGINEER OF TO-DAY AND THE QUALITIES OF MIND AND CHARACTER WHICH ARE NEEDED TO MEET THEM

J. G. White Vol. xxii—1903, pp. 569-578

Outline of the scope and character of training required by engineers. Qualifications for successful engineer.

Discussion, incorporated with that of paper by L. A. Osborne on "Proper Qualifications of Electrical Engineering School Graduates, from the Manufacturer's Standpoint."

THE PROPER QUALIFICATIONS OF ELECTRICAL ENGINEERING SCHOOL GRADUATES FROM THE TELEPHONE ENGINEERS STANDPOINT

Bancroft Gherardi, Jr. Vol. xxii—1903, pp. 579-586

Outline of the functions of a technical education and criticisms of technical graduates.

Discussion, incorporated with that of paper by L. A. Osborne on "Proper Qualifications of Electrical Engineering School Graduates, from the Manufacturer's Standpoint."

PROPER QUALIFICATIONS OF ELECTRICAL ENGINEERING SCHOOL GRADUATES, FROM THE MANUFACTURER'S STANDPOINT

L. A. Osborne Vol. xxii—1903, pp. 587-591

Suggestions for improvement of technical education of engineers for manufacturing work.

Discussion (including that of paper by J. G. White on "The Problems that are Facing the Electrical Engineer of To-day and the Qualities of Mind and Character which are Needed to Meet them"; and paper by Bancroft Gherardi, Jr., on "The Proper Qualifications of Electrical Engineering School Graduates from the Telephone Engineer's Standpoint"), pp. 592-598, by Messrs. W. E. Goldsborough, Prof. Jacoby, A. F. Ganz, F. C. Caldwell, Hugo Diemer, Prof. Allen, Prof. Waldo, J. G. White, H. S. Carhart and D. B. Rushmore.

Engineering education from a teacher's standpoint.

THE TYPICAL COLLEGE COURSES DEALING WITH THE PROFESSIONAL AND THEORETICAL PHASES OF ELECTRICAL ENGINEERING

Dugald C. Jackson **Vol. xxii—1903, pp. 599-607**

Characterization of students entering college and outline of studies requisite for their training as electrical engineers. Classification of typical electrical engineering courses.

No discussion.

ENGINEERING ENGLISH

T. J. Johnston **Vol. xxii—1903, pp. 609-614**

Examples of poor engineering English and a plea for adequate instruction in English.

No discussion.

TRAINING AN ARTIST IN THE FORCES OF NATURE

E. H. Mullin **Vol. xxii—1903, pp. 615-622**

Faults in modern educational methods. Discussion of education as an art and as a science.

No discussion.

THE ATTITUDE OF THE TECHNICAL SCHOOL TOWARD THE PROFESSION OF ELECTRICAL ENGINEERING

Henry H. Norris **Vol. xxvi—1907, pp. 1429-1439**

Outline of the purpose of technical education, followed by brief résumé of the history of technical schools in the United States, with special reference to Sibley College and its early development. Short description of present curriculum at Sibley College and method of rating students searching employment. Table of present occupation of Sibley graduates.

Discussion, incorporated with paper by V. Karapetoff on "On the Concentric Method of Teaching Electrical Engineering."

ON THE CONCENTRIC METHOD OF TEACHING ELECTRICAL ENGINEERING

V. Karapetoff **Vol. xxvi—1907, pp. 1441-1456**

Description of a new method of education that begins by establishing a general view of the scope and character of the career, and then works gradually outward, taking up the auxiliary studies as the student learns to appreciate their use and importance. The general exposition of the method is followed by a suggested schedule of subjects for a complete electrical engineering course.

Discussion (including that of paper by Henry H. Norris on "The Attitude of the Technical School Toward the Profession of Electrical Engineering"), pp. 1457-1468, by Messrs. V. Karapetoff, F. D. Crocker, Gano Dunn, William Esty, G. W. Patterson, Lester W. Gill, L. D. Nordstrum, Charles F. Scott and J. J. Carty.

Criticisms of the concentric method of education. General remarks on methods used in various important engineering schools. Motion carried to appoint Educational Committee.

THE BEST ENGINEERING EDUCATION

Charles F. Scott Vol. xxvii—1908, pp. 67-78

General scope and purpose of engineering education; followed by a digest of all the educational papers presented before the Institute since 1892.

Discussion, incorporated with Chas. P. Steinmetz's paper on "Electrical Engineering Education."

ELECTRICAL ENGINEERING EDUCATION

Chas. P. Steinmetz Vol. xxvii—1908, pp. 79-85

Criticism of the American system of education, with special reference to the compensation of teachers, etc.

Discussion (included with the paper by Chas. F. Scott on "The Best Engineering Education"), pp. 86-135, by Messrs. Chas. F. Scott, Chas. P. Steinmetz, L. A. Osborne, H. E. Clifford, F. B. Crocker, H. W. Buck, W. S. Franklin, L. B. Stillwell, Albert F. Ganz, J. G. White, W. E. S. Temple, Louis A. Ferguson, Samuel Sheldon, P. H. Thomas, W. L. Robb, C. O. Mailloux, A. E. Kennelly, H. P. Coho, A. S. McAllister, O. J. Ferguson, H. W. Blake, and Dugald C. Jackson.

Comprehensive discussion on the scope and character of engineering education, pointing out defects and suggesting reforms.

THE NEW METHOD OF TRAINING ENGINEERS

Magnus W. Alexander Vol. xxvii—1908, pp. 1459-1471

Experience with the General Electric apprenticeship course at Lynn. Plan outlined for co-operative engineering course between colleges and factories.

Discussion, incorporated with paper by B. A. Behrend on "The Relation of the Manufacturing Company to the Technical Graduate."

RELATION OF THE MANUFACTURING COMPANY TO THE TECHNICAL GRADUATE

David B. Rushmore Vol. xxvii—1908, pp. 1473-1476

No discussion.

THE RELATION OF THE MANUFACTURING COMPANY TO THE TECHNICAL GRADUATE

B. A. Behrend Vol. xxvii—1908, pp. 1477-1479

Discussion (including that of paper by Magnus W. Alexander on "The New Method of Training Engineers," and paper by David B. Rushmore on "Relation of the Manufacturing Company to the Technical Graduate"), pp. 1480-1497, by Messrs. B. A. Behrend, J. P. Jackson, Elihu Thomson, Percy H. Thomas, Morgan Brooks, Henry H. Norris, Charles P. Steinmetz, Dugald C. Jackson, C. A. Adams, A. F. Ganz, Charles F. Scott, Gano Dunn and M. W. Alexander.

General discussion of the advantages and disadvantages of co-operative system of education from different points of view.

FUNDAMENTAL PRINCIPLES OF INDUSTRIAL EDUCATION

Herman Schneider — Vol. xxviii—1909, pp. 269-278

Description of a system of education involving co-operation between the industrial companies and public schools, the pupils dividing their time between the factory and the school. Results from systems in use.

Discussion, pp. 279-311, by Messrs. Harry Barker, Arthur D. Dean, C. E. Downton, Charles P. Steinmetz, W. S. Franklin, John Price Jackson, Otis Allen Kenyon, Dugald C. Jackson, A. R. Dennington, Herman Schneider, Charles S. Howe, V. Karapetoff, G. M. Basford, Jackson C. Humphries, Ralph W. Pope, Sidney W. Ashe, Franklin Phillips and Willard S. Atkinson.

Discussion of general and industrial education, with special reference to the co-operative system, night schools, apprenticeship courses and lecture courses for employees.

THE TRAINING OF NON-TECHNICAL MEN

C. R. Dooley — Vol. xxviii—1909, pp. 1095-1101

Description of the apprenticeship and night school systems used in training non-technical men employed by the Westinghouse Companies at East Pittsburg.

Discussion, incorporated with that of Dr. Charles P. Steinmetz's paper on "The Value of Classics in Engineering Education."

THE VALUE OF CLASSICS IN ENGINEERING EDUCATION

Charles P. Steinmetz — Vol. xxviii—1909, pp. 1103-1106

Criticism of modern engineering education.

Discussion, pp. 1107-1131, including discussion of paper by Mr. C. R. Dooley on "The Training of Non-Technical Men," by Messrs. Charles P. Steinmetz, Frederick P. Fish, Comfort A. Adams, Farley Osgood, M. G. Lloyd, John C. Parker, David B. Rushmore, Clayton H. Sharp, James G. White, C. R. Dooley, George F. Sever, George H. Gibson, A. E. Kennelly, H. W. Fisher, J. Dalemont and Ralph D. Mershon.

General discussion of the character and scope of training required by electrical engineers.

EDUCATION FOR LEADERSHIP IN ELECTRICAL ENGINEERING

Samuel Sheldon — Vol. xxix—1910, pp. 649-662

Statistical study of the importance of electrical engineering and the electrical engineer, followed by general suggestions for the modification of existing college practices, with reference to increasing the chances of engineering graduates becoming leaders.

Discussion, pp. 663-674, by Messrs. Charles S. Howe, Abraham Flexner, J. W. Lieb, Jr., A. E. Kennelly, William McClellan, L. B. Stillwell, William J. Berry, A. S. Langsdorf and Samuel Sheldon.

General remarks on electrical engineering education.

2. GENERAL THEORY

THEORETICAL INVESTIGATION OF SOME OSCILLATIONS OF EXTREMLY HIGH POTENTIAL IN ALTERNATING HIGH-POTENTIAL TRANSMISSIONS

Charles Proteus Steinmetz — Vol. xviii—1901, pp. 383-405

Mathematical investigation of the effect of the exponential term in the general equation for alternating-current circuits, followed by numerical examples showing the nature of disturbances due to opening a short-circuit on the line and to connecting the line to a source of alternating-current energy.

Discussion, incorporated with that of paper by E. W. Rice, Jr., on "The Control of High-Voltage Systems of Large Power."

A DISCUSSION OF SOME POINTS IN ALTERNATING-CURRENT THEORY

W. S. Franklin — Vol. xxi—1903, pp. 589-501

Discussion of ideas and conceptions with reference to presentation of theory of alternating current. Criticisms of Dr. Steinmetz's methods—Polar diagram vs. crank diagram, necessity of choosing signs in circuit problems, topographical vs. vector methods, physical basis of transformer and induction motor equations, vector representation of power.

No discussion.

THE EFFECT OF IRON IN DISTORTING ALTERNATING CURRENT WAVE FORM

Frederick Bedell and Elbert B. Tuttle — Vol. xxv—1906, pp. 671-691

Theoretical investigation of the relation between the third harmonic introduced by iron into the exciting current and the hysteresis loop. Also, an exposition of the relation between the area of the hysteresis loop and the angle of hysteresis advance.

Discussion, pp. 692-714, by Messrs. Chas. P. Steinmetz, Philip Torchio, W. S. Franklin, Frederick Bedell, Harold Pender, A. Henry Pikler, S. P. Grace, H. B. Tuttle, S. N. Kintner and A. W. Copley.

Full discusison of wave distortion due to iron, showing that other harmonics than the third modify Professor Bedell's conclusions. References to early work of Huguet, Froelich, Kennelly, Gerosa, Finzi, Eickemeyer and Steinmetz. Effect of wave distortion with different polyphase transformer connections. Derivation of the parabolic law of magnetic induction. Oscillograms of induced e. m. f. showing effect of primary impedance on wave form in core loss tests and in transformers.

THE PROPERTIES OF ELECTRONS
PRESIDENTS ADDRESS

Samuel Sheldon — Vol. xxvi—1907, pp. 937-968

Conception of electrons and brief exposition of their properties. Application of electronic theory to the explanation of the fundamental principles of electrophysics—conduction of electricity in gases, vapors and

solids; contact, thermal and electromagnetic generation of e. m. f.; dielectric phenomena; radiation, and luminescence.

No discussion.

THE GENERAL EQUATIONS OF THE ELECTRIC CIRCUIT

Charles P. Steinmetz **Vol. xxvii—1908, pp. 1231-1305**

Mathematical development and physical interpretation of general equations for the electric circuit—covering standing waves, free oscillations and traveling waves in simple and complex circuits. Numerical examples of overhead and underground power transmission circuits, and telephone, telegraph and submarine cable circuits.

Discussion, pp. 1306-1307, by Messrs. Frederick Bedell, Dugald C. Jackson, H. L. Wallau; Charles P. Steinmetz and W. S. Franklin.

General remarks on Steinmetz's equations. Brief exposition of Heaviside's method of explaining electric wave motion.

AN IMPERFECTION IN THE USUAL STATEMENT OF THE FUNDAMENTAL LAW OF ELECTROMAGNETIC INDUCTION

Carl Hering **Vol. xxvii—1908, pp. 1341-1351**

Description and discussion of an experiment that tends to show that present methods of teaching do not give a clear conception of the fundamental law of electromagnetic induction.

Discussion, pp. 1352-1371, by Messrs. Charles P. Steinmetz, A. E. Kennelly, Elihu Thomson, W. S. Franklin, Percy H. Thomas, W. P. Graham, George T. Hanchett, George A. Campbell, Tracy D. Waring and Carl Hering.

General remarks on the laws of electromagnetic induction and criticisms of the author's experiment.

GRAPHICAL TREATMENT OF THE ROTATING FIELD

R. E. Hellmund **Vol. xxvii—1908, pp. 1373-1394**

Development of a graphical method of investigating a rotating field and examples of its application.

Discussion, p. 1395, by Messrs. Comfort A. Adams and R. E. Hellmund.

A TRIGONOMETRIC METHOD FOR THE SOLUTION OF ALTERNATING-CURRENT PROBLEMS

Harold Pender **Vol. xxvii—1908 pp. 1397-1424**

Development of a short method for solving alternating-current problems with examples of its application to single-phase and three-phase transmission lines, transformers and induction motors. Tables of reactance, capacity, resistance and drop factors for use in such calculations.

Discussion, pp. 1424-1427, by Messrs. Comfort A. Adams, W. A. Del Mar and L. W. Rosenthal.

Magnitude of errors involved by this method when applied to transmission line calculations.

EVEN HARMONICS IN ALTERNATING-CURRENT CIRCUITS

John B. Taylor — Vol. xxviii—1909, pp. 725-732

Description of conditions under which even harmonics may be produced in commercial circuits, with special reference to the effect of stray direct current on the performance of stationary transformers. Tests and oscillograms of transformer exciting current with stray direct current in the windings.

Discussion, pp. 733-736, by Messrs. Frederick Bedell, V. Karapetoff, Charles F. Scott, Charles P. Steinmetz and John B. Taylor.

Production of even harmonics in alternators and effect of direct-current in the windings of a transformer upon the losses.

VECTOR POWER IN ALTERNATING-CURRENT CIRCUITS

A. E. Kennelly — Vol. xxix—1910, pp. 1233-1267

Analytical study of vector quantities combating the use of wattless power and wattless current, and advocating the standardization of the counter-clockwise rotation of vectors.

Discussion, pp. 1268-1280, by Messrs. C. P. Steinmetz, Gano Dunn, William W. Crawford, John B. Taylor, L. T. Robinson, F. Creedy and A. E. Kennelly.

Polar diagram vs. the crank diagram for vector representation of alternating quantities. Representation of vector power by Mobius & Grassman system of point-analysis.

3. MEASUREMENT AND INSTRUMENTS

A. UNITS, STANDARDS AND LABORATORIES

A NOTE ON AN ACETYLENE-IN-OXYGEN FLAME

Clayton H. Sharp Vol. xix—1902, pp. 51-54

Description of an acetylene flame burner which might be used as a standard of intensity. Spectrophotometric curve of acetylene and other flames.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

THE PRESENT STATUS OF THE QUESTION OF A STANDARD OF LIGHT

Clayton H. Sharp Vol. xix—1902, pp. 55-57

Brief reference to some of the shortcomings of the present standards of luminous intensity. Advantages of acetylene flame as standard.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

MAGNETIC UNITS AND OTHER SUBJECTS THAT MIGHT OCCUPY ATTENTION AT THE NEXT INTERNATIONAL ELECTRICAL CONGRESS

A. E. Kennelly Vol. xxii—1903, pp. 529-536

Discussion of the disadvantages of the c. g. s. system. Names for all the c. g. s. electromagnetic and electrostatic units suggested for adoption by the International Electrical Congress.

Discussion, pp. 537-538, by Messrs. Carl Hering, W. E. Goldsborough and J. P. Jackson.

THE LEGALIZED STANDARD OF ELECTROMOTIVE FORCE

Henry S. Carhart Vol. xxii—1903, pp. 521-523

Legally determined values of e. m. f. of the Clark standard cell. Ratio between the Clark and Weston cells. Reasons for recommending the adoption of the Weston cell as standard.

Discussion, pp. 524-527, by Messrs. C. H. Sharp, Carl Hering and W. E. Goldsborough.

Importance of standard cell and potentiometer in practical work. Motion passed to refer specifications for standard cell to Board of Directors.

THE NATIONAL BUREAU OF STANDARDS

S. W. Stratton and E. B. Rosa Vol. xxiv—1905, 999-1050

Description of the Bureau of Standards, its origin, functions, organization, equipment and work. Also a description of the laboratory at the Louisiana Purchase Exposition.

Discussion, incorporated with that of paper by Clayton H. Sharp on "A Testing Laboratory in Practical Operation."

A TESTING LABORATORY IN PRACTICAL OPERATION

Clayton H. Sharp **Vol. xxiv—1905, pp. 1051-1060**

Discussion of the work done by the Electrical Testing Laboratories—its nature and scope. Classification of the orders and the clients.

Discussion (including that of paper by S. W. Stratton and E. B. Rosa on "The National Bureau of Standards"), pp. 1061-1065, by Messrs. F. B. Crocker, W. E. Goldsborough, C. O. Mailloux, George F. Sever, C. A. Doremus, William McClellan, S. W. Stratton, John W. Lieb, Jr., and E. B. Rosa.

General remarks on the scope and importance of standardization laboratories. Desirability of international standardization.

PRIMARY STANDARD OF LIGHT

Charles P. Steinmetz **Vol. xxvii—1908, pp. 1319-1324**

Criticism of primary standard based on energy of radiation, recommending standard composed of three component colors of definite wave lengths.

Discussion, pp. 1325-1339, by Messrs. A. E. Kennelly, Edwin P. Hyde, W. S. Franklin, Carl Hering, Clayton H. Sharp, C. A. Perkins, John B. Taylor, E. B. Rosa, H. S. Carhart and Charles P. Steinmetz.

General remarks on Steinmetz's proposed standard. Motion carried to refer question of establishing standard to the Bureau of Standards.

B. ELECTRICAL MEASUREMENTS AND INSTRUMENTS

THE TRANSFORMER FOR MEASURING LARGE DIRECT CURRENTS

Harris J. Ryan **Vol. xviii—1901, pp. 169-183**

Description of the theory of operation, the design and construction of the transformer. Account of tests demonstrating the degree of accuracy under various conditions, such as occur in testing switchboard instruments in place.

Discussion, pp. 184-190, by Messrs. Geo. T. Hanchett, Gano S. Dunn, Samuel Sheldon, A. E. Kennelly, C. O. Mailloux and Townsend Wolcott.

Criticism of the method and answers thereto.

SYNCHRONISM AND FREQUENCY INDICATION

Paul M. Lincoln **Vol. xviii—1901, pp. 255-270**

Description of construction and theory of operation of the Lincoln synchroscope and the Lincoln frequency indicator.

Discussion, incorporated with that of paper by William Hand Browne, Jr., on "Power-Factor Indicators."

SOME FUNDAMENTALS OF ELECTRIC METERS

Caryl D. Haskins **Vol. xviii—1901, pp. 271-276**

Discussion of the relations between torque, friction and permanency under various surrounding conditions.

Discussion, incorporated with that of paper by William Hand Browne, Jr., on "Power-Factor Indicators."

METERING OF ELECTRICAL ENERGY

Harry P. Davis Vol. xviii—1901, pp. 277-285

Requirements of a good energy meter and choice of meter rating for different kinds of load based on extensive experience.

Discussion, incorporated with that of paper by William Hand Browne, Jr., on "Power-Factor Indicators."

POWER-FACTOR INDICATORS

William Hand Brown, Jr. Vol. xviii—1901, pp. 287-312

General discussion of power-factor regulation and methods of measuring power-factor. Description of numerous types and forms of power-factor meters, phase-meters and wattless power meters, and wattless current meters, with short description of the theory of each general type.

Discussion (including that of paper by Paul M. Lincoln on "Synchronism and Frequency Indication"; paper by Caryl D. Haskins on "Some Fundamentals of Electric Meters"; paper by Harry P. Davis on "Metering of Electrical Energy"), pp. 313-338, by Messrs. W. S. Barstow, Chas. P. Steinmetz, H. W. Buck, Gano S. Dunn, Ralph D. Mershon, C. F. Scott, Carl Hering, C. O. Mailloux, F. S. Holmes, E. A. Sperry, Henri Boy De La Tour, Henry W. Fisher, H. G. Stott, Chas. Janisch and C. D. Haskins.

Relative merits and comparative performance of direct-current and induction motors. Desirability of charging for apparent and quadrature power. Two-rate meter for peak load differentiation.

LIQUID POTENTIOMETER; DETERMINING ELECTROLYTIC RESISTANCES WITH DIRECT-CURRENT INSTRUMENTS

Carl Hering Vol. xix—1902, pp. 317-323

Description of the instrument and methods of using it.

Discussion, incorporated with that of paper by W. R. Whitney on "Colloids."

THE ELECTROSTATIC WATTMETER IN COMMERCIAL MEASUREMENTS

Miles Walker Vol. xix—1902, pp. 1035-1045

Discussion of the advantages and disadvantages of the Electrometer. Simple formulas for calculating the torque on the vanes of an electrometer under various practical conditions. Description of a bifilar suspension electrometer.

Discussion, incorporated with that of paper by Charles Edward Skinner on "Energy Loss in Commercial Insulating Materials When Subjected to High-potential Strains."

A NEW CURVE TRACING INSTRUMENT

Robt. B. Owens Vol. xix—1902, pp. 1123-1129

Description of the instrument and directions for checking current and

e. m. f. waves, and for measuring angular velocity variations in one revolution.

Discussion, p. 1130, by F. A. C. Perrine and C. P. Steinmetz.

THE CATHODE RAY ALTERNATING-CURRENT WAVE INDICATOR

Harris J. Ryan — Vol. xxii—1903, pp. 539-548

Description of the construction and mode of operation of the cathode tube wave tracer.

Discussion, pp. 549-552, by Messrs. G. S. Dunn, P. H. Thomas, Harris J. Ryan, A. F. Ganz, William J. Hammer, C. H. Sharp, H. W. Fisher, A. S. Langsdorf and W. E. Goldsborough

A GRAPHIC RECORDING AMMETER

A. H. Armstrong — Vol. xxii—1903, pp. 689-694

Description of the construction and operation of the Armstrong recording instruments for railway testing.

No discussion.

SOME NOTES ON POLYPHASE METERING

J. D. Nies — Vol. xxiv—1905, pp. 165-180

Brief outline of nature and magnitude of errors introduced by presence of shunt and series instrument transformers. Relative merits of single-meter, two-meter and three-meter and polyphase meter methods for measuring energy in three-phase circuits.

Discussion, incorporated with paper by W. J. Mowbray on "Maintenance of Meters."

NOTES ON THE USE OF INSTRUMENTS ON SWITCHBOARDS

F. P. Cox — Vol. xxiv—1905, pp. 181-184

Brief mention of some of the factors which enter into the choice of watt-hour meter rating for a given service, and reference to some of the errors that can be avoided by proper selection and installation of watt-hour meters.

Discussion, incorporated with paper by W. J. Mowbray on "Maintenance of Meters."

THE OSCILLOGRAPH AND ITS USES

Lewis T. Robinson — Vol. xxiv—1905, pp. 185-214

Description of various methods and apparatus for measuring wave form—Joubert point-by-point method, Elihu Thomson continuous method, Rosa curve tracer, General Electric wave meter, Hospitalier ondograph, Blondel & Duddell oscillographs. Bibliography on subject of wave-form measurement.

Discussion, incorporated with paper by W. J. Mowbray on "Maintenance of Meters."

MAINTENANCE OF METERS

W. J. Mowbray Vol. xxiv--1905, pp. 215-218

General description of a rotating standard watt-hour meter with plurality of current coils. General remarks on methods of increasing permanence of calibration.

Discussion (including that of paper by J. D. Nies on "Some Notes on Polyphase Metering"; paper by F. P. Cox on "Notes on the Use of Instruments on Switchboards," and paper by Lewis T. Robinson on "The Oscillograph and Its Uses"), pp. 219-245, by Messrs. J. W. Lieb, Jr., Caryl D. Haskins, Edward B. Rosa, Clayton H. Sharp, A. R. Everest, W. H. Pratt, G. C. Van Buren, A. H. Ackerman, J. F. Stevens, William McClellan, Charles Hewitt, William Bradshaw, Stephen Q. Hayes, C. W. Hutton, J. W. Swaren, R. F. Monges, C. L. Cory and F. E. Smith.

General remarks on the choice, installation and maintenance of indicating and integrating switchboard instruments. Tests on permanence of calibration of very large number of watt-hour meters giving the limits of accuracy.

METHODS OF MEASUREMENT OF HIGH ELECTRICAL PRESSURES

S. M. Kintner Vol. xxiv—1905, pp. 421-444

Brief résumé of the various methods of measuring very high e. m. f's., pointing out the principal limitations of each. Experimental study of the spark gap for e. m. f. measurement, showing the effect of various current limiting devices, grounding and shielding. Description and discussion of the advantages of an oil-immersed electrostatic voltmeter for e. m. f's. up to 100,000 volts.

Discussion, pp. 445-451, by Messrs. Charles P. Steinmetz, Samuel Sheldon, C. O. Mailloux, H. G. Stott, H. W. Fisher, E. F. Northrup, Charles A. Perkins and S. M. Kintner.

Advantages of potential transformers in very high e. m. f. measurements. Accuracy of needle-gap measurements and effect of degree of sharpness thereon.

A NEW INSTRUMENT FOR THE MEASUREMENT OF ALTERNATING CURRENTS

E. F. Northrup Vol. xxiv- 1905, pp. 741-757

Description of the construction and mode of operation of a hot-wire instrument devised for zero measurements of either alternating current or direct current, together with analytical discussion of the mode of adjustment for different kinds of work.

Discussion, pp. 758-760, by Messrs. E. F. Northrup, H. G. Stott, F. N. Waterman and H. W. Fisher.

General remarks concerning the probable limitations of the instruments.

THREE-PHASE POWER FACTOR

Austin Burt Vol. xxvii—1908, pp. 801-814

Derivation of formula for the mean power-factor of a three-phase system, together with a method of determining power-factor from wattmeter readings.

Discussion, pp. 815-817, by Messrs. Comfort A. Adams, Frederick Bedell, H. L. Wallau and B. A. Behrend.

Physical demonstration of the two-wattmeter method of determining three-phase power factor.

METHOD OF TESTING TRANSFORMER CORE LOSSES GIVING SINE WAVE RESULTS ON COMMERCIAL CIRCUITS

L. W. Chubb Vol. xxviii—1909, pp. 417-431

The use, construction and limits of accuracy of a special instrument—iron-loss voltmeter—consisting of a wattmeter connected in series with an exciting winding on a steel core and calibrated to read the impressed voltage of sine wave e. m. f. Also a description of a method of adjusting form factor in core-loss tests.

Discussion, pp. 432-438, by Messrs. Frederick Bedell, Charles P. Steinmetz, M. G. Lloyd, L. T. Robinson, Charles F. Scott and L. W. Chubb.

General discussion of the use and limitations of iron-loss voltmeter. Description of a method for obtaining sine wave from a commercial circuit.

C. NON-ELECTRICAL MEASUREMENTS AND INSTRUMENTS

ANGULAR VARIATIONS IN STEAM ENGINES

P. O. Keilholtz Vol. xviii—1901, pp. 703-740

Mathematical investigation of the turning moments due to steam and to inertia of the reciprocating parts, developing method of determining the relation between balancing effect of fly-wheel and the deviation from the position of absolutely uniform speed. Description of method of measuring any velocity variations by means of electrically driven tuning fork with detailed results of tests on a tandem compound engine.

Discussion, incorporated with that of paper by Walter I. Slichter on "Angular Velocity in Steam Engines in Relation to Paralleling of Alternators."

AN INTEGRATING PHOTOMETER FOR GLOW LAMPS AND SOURCES OF LIGHT INTENSITY

Chas. P. Matthews Vol. xx—1902, pp. 59-70

Theory, design, construction and operation of a special intensity photometer invented by the author for use in making photometric measurements of incandescent lamps and flames.

Discussion, incorporated with that of paper by Clayton H. Sharp on "The Commercial Accuracy of Photometrical Measurements."

SOME METHODS OF PHOTOMETRY AS APPLIED TO INCANDESCENT LAMPS

J. T. Marshall — Vol. xx—1902, pp. 77-85

A description of method of calibrating and using sliding scale photometer for commercial testing and inspection of incandescent lamps.

Discussion, incorporated with that of paper by Clayton H. Sharp on "The Commercial Accuracy of Photometrical Measurements."

THE COMMERCIAL ACCURACY OF PHOTOMETRICAL MEASUREMENTS

Clayton H. Sharp — Vol. xx—1902, pp. 87-93

Experimental investigation of the limits of accuracy in different classes of photometrical measurements.

Discussion (including that of paper by Chas. P. Matthews on "Integrating Photometer for Glow Lamps and Sources of Light Intensity"; paper by Douglass Burnett on "Distributed Lighting"; and paper by J. T. Marshall on "Some Methods of Photometry as Applied to Incandescent Lamps"), pp. 94-110, by Messrs. Douglass Burnett, Edward L. Nichols, Francis R. Upton, L. B. Marks, W. S. Howell, F. S. Smith, Edward B. Rosa, Calvin W. Rice, William J. Hammer, W. S. Stratton, Clayton H. Sharp, J. T. Marshall, Chas. F. Scott, Chas. P. Matthews, Edward P. Thompson, Alex J. Wurts, R. H. Henderson, Max Von Reckinghausen, P. M. Lincoln, N. W. Storer and F. W. Jones.

Merits of mean spherical candle-power method of rating illuminants. Methods of measuring illumination. Description of Cooper-Hewitt mercury vapor lamp.

MEASUREMENT OF TEMPERATURE BY ELECTRICAL MEANS

Edwin F. Northrup — Vol. xxv—1906, pp. 473-504

Theory, construction and connections for resistance pyrometers, profusely illustrated with drawings and connection diagrams.

Discussion, pp. 505-506, by Mr. E. F. Schuetz.

A NEW CO_2 RECORDER

C. O. Mailloux — Vol. xxvi—1907, pp. 1771-1787

Description of Orsat apparatus followed by detailed description of the Westover recorder.

Discussion, p. 1788, by A. A. Adler.

THE MEASUREMENT OF ROTARY SPEEDS OF DYNAMO MACHINES BY THE STROBOSCOPIC FORK

A. E. Kennelly and S. E. Whiting — Vol. xxvii—1908, pp. 631-646

Brief historical outline of stroboscopic fork and its use with special reference to the work of Dr. Chas. V. Drysdale, followed by a description of the construction and mode of operation of a new modification of the instrument arranged for portable work.

Discussion, pp. 647-649, by Messrs. J. B. Taylor, C. A. Perkins, C. H. Sharp and A. E. Kennelly.

Range of speed obtained with ordinary stroboscopic fork.

NOTE ON A SIMPLE DEVICE FOR FINDING THE SLIP OF AN INDUCTION MOTOR

Charles A. Perkins Vol. xxiv—1905, pp. 879-880

Description of device.

D. INSTRUMENT TRANSFORMERS

THE CURRENT TRANSFORMER

Kenneth L. Curtis Vol. xxv—1906, pp. 715-726

Method of predetermining the performance of series transformer from tests of exciting current and internal losses. Method of measuring small inductances.

Discussion, pp. 727-734, by Mr. L. T. Robinson.

Testing of series transformer for ratio and phase angle. Oscillograms of exciting current of series transformers.

ELECTRICAL MEASUREMENTS ON CIRCUITS REQUIRING CURRENT AND POTENTIAL TRANSFORMERS

L. T. Robinson Vol. xxxviii—1909, pp. 1005-1039

Theoretical discussion of the effects of instrument transformers on the accuracy of ammeter and wattmeter measurements, together with tables of correction factors for phase angle error in power measurements. Theory of operation of series transformer showing effects of variation in frequency, secondary impedance, line current, power-factor and wave form. Description of methods of testing series and shunt instrument transformers with ratio and phase angle performance curves from actual test.

Discussion, pp. 1040-1052, by Messrs. C. H. Sharp, M. G. Lloyd, L. W. Chubb, J. Dalemont, Albert F. Ganz and L. T. Robinson.

Methods of measuring ratio and phase angle of current transformers and correction factor for instrument transformers in polyphase measurements.

SOME RECENT DEVELOPMENTS IN EXACT ALTERNATING-CURRENT MEASUREMENTS

Clayton H. Sharp and William W. Crawford Vol. xxix—1910, pp. 1517-1541

Description of design and construction of various precision devices—synchronous reversing key, adjustable mutual inductance, phase shifter and heavy current non-inductive shunt—showing their application in the accurate measurement of ratio and phase angle of series and shunt instrument transformers and in an alternating-current potentiometer.

Discussion, pp. 1542-1552, by Messrs. V. Karapetoff, L. T. Robinson, W. H. Pratt, C. P. Steinmetz, Clayton H. Sharp and William W. Crawford.

General remarks on precision measurements of alternating-current quantities. Description of a water-cooled electrodynamometer, also of a method of measuring very high frequency alternating current.

4. DIELECTRICS AND DIELECTRIC PHENOMENA

STATIC STRAINS IN HIGH-TENSION CIRCUITS AND THE PROTECTION OF APPARATUS

Percy H. Thomas — Vol. xix—1902, pp. 213-264

Discussion of the nature, causes and effects of disturbances of the potential in a transmission system, such as occur when switches are opened or closed, grounds, short circuits, etc. Description of the mode of operation of the static interrupter and the spark gap lightning arrester with series and shunt resistors. Experimental study of the effects of static disturbances and the degree of protection afforded by choke coils and static interrupters. Description of mechanical model for demonstrating the travel of waves over a transmission line.

Discussion, pp. 265-276, by Messrs. C. P. Steinmetz, F. O. Blackwell, H. W. Fisher, Philip Torchio, P. H. Thomas and B. A. Behrend.

Results of investigation of needle gap, showing the effect of sharpness on sparking distance; also results of experimental investigation of high-tension transmission line, showing the effects of switching with oil and air-break switches. Mathematical study of distribution of potential stress in model as to time and distance measured from time and position of application.

ENERGY LOSS IN COMMERCIAL INSULATING MATERIALS WHEN SUBJECTED TO HIGH-POTENTIAL STRAINS

Charles Edward Skinner — Vol. xix—1902, pp. 1047-1062

Experimental study of energy losses in dielectrics, showing the effects of variation in voltage, temperature, moisture and frequency. The exact nature of the dielectric not given. Test of energy losses in 5,000-kilowatt engine type alternator of Manhattan Railway Company.

Discussion (including that of paper by Percy H. Thomas on "The Function of Shunt and Series Resistance in Lightning Arresters," and paper by Miles Walker on "Electrostatic Wattmeter in Commercial Measurements"), pp. 1063-1073, by Messrs. Edw. L. Nichols, Chas. F. Hopewell, Chas. E. Skinner, W. S. Andrews, F. A. C. Perrine, Elihu Thompson, William Maver, Jr., P. B. Woodworth, C. P. Steinmetz and P. H. Thomas. Observed dielectric strength of mica under oil. Electrolytic conduction in cable insulation. Effect of moisture on dielectric strength of oil. General remarks on lightning arresters.

SOME RECOMMENDATIONS CONCERNING ELECTRICAL AND MECHANICAL SPECIFICATIONS OF TROLLEY INSULATORS

Samuel Sheldon & John D. Keiley — Vol. xxii—1903, pp. 231-239

Description of methods and results of testing strain insulators for tensile strength, breakdown e. m. f., insulation resistance and determination of maximum working temperature for round top trolley suspension

insulators. Specifications for various forms of insulators for overhead trolley construction.

Discussion, pp. 240-242, by Messrs. Joseph Sachs, Ralph D. Mershon and Samuel Sheldon.

Recommendations for standard railway insulator specifications. Alternating current vs direct current for testing insulators for use on direct current circuits.

THE TESTING OF ELECTRICAL APPARATUS FOR DIELECTRIC STRENGTH

P. H. Thomas Vol. xxii—1903, pp. 353-360

Brief discussion of the difficulties and dangers of testing dielectrics, followed by a list of precautions and general recommendations for making such tests.

Discussion, pp. 361-371, by Messrs. L. A. Hawkins, M. H. Gerry, Jr., H. G. Stott, J. S. Peck, P. M. Lincoln, Gano S. Dunn, P. H. Thomas, W. L. Waters, C. E. Skinner, Ralph D. Mershon, A. S. Langsdorf, Henry Pikler, Louis Bell and P. G. Gossler.

General discussion of dielectric testing; methods of voltage application and measurement; duration of test; effect of fatigue; choice of value of test voltage, etc. Wave distortion due to resistor in series with transformer. Experience with overhead grounded wire.

ELECTRIC CABLES FOR HIGH VOLTAGE SERVICE

Henry W. Fisher Vol. xxii—1903, pp. 417-420

Brief discussion of requirements to be met in the manufacture, installation and operation of rubber and paper insulated cables.

Discussion, incorporated with that of paper by H. G. Stott on "The Use of Automatic Means for Disconnecting Disabled Apparatus."

THE CONDUCTIVITY OF THE ATMOSPHERE AT HIGH VOLTAGES

Harris J. Ryan Vol. xxiii—1904, pp. 101-134

Analytical discussion of corona phenomena, reviewing previous experiments of the author and others, followed by account of experimental investigation of corona losses in the laboratory with a cathode tube wave tracer, showing effects of conductor dimensions and atmospheric conditions upon critical voltage, all of which are expressed in equation for critical e. m. f.

Discussion, pp. 135-145 and 168-170, by Messrs. C. F. Scott, Samuel Sheldon, Harold B. Smith, P. H. Thomas, Harris J. Ryan, P. M. Lincoln, G. T. Hanchett, Elihu Thomson, Ralph D. Mershon, S. M. Kintner, H. W. Fisher, W. A. Blanck and C. E. Freeman.

General remarks on losses to atmosphere at high e. m. f's., with special reference to the critical e. m. f. and the factors which affect it. Difficulties in measuring very high e. m. f's.

TERMINALS AND BUSHINGS FOR HIGH-PRESSURE TRANSFORMERS

Walter S. Moody Vol. xxiii—1904, pp. 225-230

Location, arrangement and insulation of transformer terminals.

Discussion, pp. 23-235, by Messrs. Ralph D. Mershon, C. E. Skinner, Irving A. Taylor, N. M. Snyder, A. C. Pratt.

General remarks on transformer terminals and terminal bushings. Weak spots in construction of transformer terminals, taps and bushings. Bushing treated as a condenser.

DATA RELATING TO ELECTRIC CONDUCTORS AND CABLES

H. W. Fisher Vol. xxiv—1905, pp. 397-414

Experimental study of the safe current-carrying capacity of insulated wires and cables. Effect of steel strands on cable impedance and method of overcoming it. Table of reactances for different sizes of wire and cables at different spacings. Tests of variation of insulation resistance and electrostatic capacity with temperature and of the heating of cables in ducts.

Discussion, pp. 415-419, by Messrs. H. G. Stott, C. W. Rice, C. O. Mailloux, Charles P. Steinmetz and H. W. Fisher.

Conditions under which high-reactance cable is desirable.

STANDARDIZING RUBBER-COVERED WIRES AND CABLES

John Langan Vol. xxv—1906 pp. 191-204

Protest against potential test as a criterion of insulation. Characteristics and properties of different grades of rubber, with instructions for easily determining the quality of rubber insulation. Suggested specifications for rubber-covered wires.

Discussion, incorporated with paper by Wallace S. Clark on "Comments on Present Underground Cable Practice."

COMMENTS ON PRESENT UNDERGROUND CABLE PRACTICE

Wallace S. Clark Vol. xxv—1906, pp. 205-213

Notes on electrolysis troubles with the low-tension cables. Effect of grounding sheath. Properties of insulation, tests of durability and record of operation of 11,000-volt 25-cycle rubber-covered leaded cables. Specifications of Rubber-Covered Wire Engineers' Association for 30 per cent. rubber compound.

Discussion (included with paper by John Langan on "Standardizing Rubber-Covered Wires and Cables"), pp. 214-239, by Messrs. H. W. Fisher, H. G. Stott, Wallace D. Clark, John Langan, Philip Torchio, A. E. Kennelly, E. W. Stevenson, Townsend Wolcott, Durand Woodman, William McClellan, J. B. Taylor, C. F. Scott, S. S. Wheeler, Dugald C. Jackson, F. R. Cutcheon, J. H. Schumacher, H. J. Gille, John Pearson and E. H. Scofield.

General discussion of the requirements of rubber insulation and the

methods of fixing and testing them. Results of tests on rubber insulated wires showing effect of percentage of Para on the performance characteristics under different conditions and indicating the method of determining the quality of insulation.

THE HEATING OF COPPER WIRES BY ELECTRIC CURRENTS

A. E. Kennelly & E. R. Shepard Vol. xxvi—1907, pp. 969-995

Experimental investigation of the heating of wires under various conditions of cooling by thermal conduction—through insulation, sand, water, and molding. Much data on thermal resistivity of insulation materials, wood and various soils. Graphical diagrams of the current carrying capacity of different sized wires under the various conditions.

No discussion.

POWER-FACTOR, ALTERNATING-CURRENT INDUCTIVE CAPACITY, CHEMICAL AND OTHER TESTS OF RUBBER-COVERED WIRES OF DIFFERENT MANUFACTURERS

Henry W. Fisher Vol. xxvi—1907, pp. 997-1020

Experimental investigation tending to show the relations that exist between the chemical composition of the rubber compound and the electrical properties of the wire—breakdown e. m. f.; insulation resistance; capacity; power-factor, and dielectric loss. Full results and test data are given in form of tables and graphical charts.

Discussion, pp. 1021-1025, by Messrs. Henry W. Fisher, Charles P. Steinmetz, E. W. Stevenson and Henry G. Stott.

General remarks on dielectric properties of cables.

HIGH-VOLTAGE MEASUREMENTS AT NIAGARA

Ralph D. Mershon Vol. xxvii—1908, pp. 845-903

Detailed account of tests on high-tension lines, covering the losses of line to atmosphere by corona, leakage over insulators, etc., with various spacings, conductor diameters, frequencies and atmospheric conditions; also the effect of the various factors in the occurrence of the critical voltage. Most data is presented in graphic form. In conclusion there are 22 items that have a distinct bearing upon the operation of very high-tension lines, and which have been deduced from the results of these tests and those made at Telluride and by Professor Ryan.

Discussion, pp. 904-929, by Messrs. Henry Doherty, Elihu Thomson, Samuel Sheldon, Henry Floy, Chas. P. Steinmetz, Percy H. Thomas, P. M. Lincoln, Carl Hering, Chas. F. Scott, A. E. Kennelly, W. L. Waters and N. M. Snyder.

General discussion of line and insulator losses at high tension. Definition of critical point and explanation of physical meaning of relation between atmospheric losses and vapor product. Analysis of insulator losses.

THE TESTING OF HIGH-VOLTAGE LINE INSULATORS

C. E. Skinner Vol. xxvii—1908, pp. 945-951

Proposed specifications for routine and design testing of high-tension line insulators.

Discussion, pp. 952-958, by Messrs. Percy H. Thomas, Ralph D. Mershon, Clayton H. Sharp, E. M. Hewlett, Chas. P. Steinmetz, C. E. Skinner and N. J. Neall.

General remarks on insulator test specifications, with special reference to methods of making the rain test.

CONDENSER TYPE OF INSULATION FOR HIGH-TENSION TERMINALS

A. B. Reynders Vol. xxviii—1909, pp. 209-220

Theory, construction and tests of special form of high-tension terminal bushing built with alternate layers of metal foil and insulation.

Discussion (including that of K. C. Randall's paper on "High-Tension Transformers and Protective and Controlling Apparatus for Outdoor Installation"), pp. 221-268, by Messrs. W. S. Moody, Percy H. Thomas, David B. Rushmore, Paul M. Lincoln, E. M. Hewlett, S. Piek, Guido Semenza, A. E. Kennelly, J. S. Peck, Ralph D. Mershon, W. S. Franklin, N. J. Neall, G. Faccioli, C. L. de Muralt, V. D. Moody, M. W. Franklin, K. C. Reynders, Ralph W. Pope, F. G. Baum, O. S. Lyford, Jr., Carl Schwartz, J B. Whitehead, John J. Frank, W. L. Waters, L. L. Perry, J. N. Kelman, August H. Kruesi and D. Kos.

General discussion of the advisability of using outdoor transformer and switching stations. Experience with outdoor high-tension apparatus. Theory and calculation of condenser type bushings. Construction of oil and asphalt filled insulating bushings.

CORONA PHENOMENA IN AIR AND OIL AND THEIR RELATION TO TRANSFORMER DESIGN

W. S. Moody and G. Faccioli Vol. xxviii—1909, pp. 769-798

Theoretical and experimental investigation of corona formation in apparatus of limited dimensions in air and in oil, showing the effect of character of surface, insulating masses, conductor masses, dimensions of conductor, etc.

Discussion, pp. 799-804, by Messrs. John B. Whitehead, J. C. Lincoln, Ralph D. Mershon, S. B. Charters, Jr., W. S. Moody and Harris J. Ryan.

Dielectric strength and conducting character of air. Mechanical strains due to corona under oil. Description of Ryan's corona voltmeter.

THE APPLICATION OF PORCELAIN TO STRAIN INSULATORS

W. H. Kempton Vol. xxix—1910, pp. 967-974

Brief account of tests on several different types of strain insulators, giving the utlimate shearing, tensile and compressive stresses.

Discussion, incorporated with that of paper by W. N. Smith on "Electric Railway Catenary Trolley Construction."

DISRUPTIVE STRENGTH WITH TRANSIENT VOLTAGES

Joseph L. R. Hayden and Charles P. Stienmetz Vol. xxix —1910, pp. 1125-1158

Account of experimental investigation of the effects of time and energy on the dielectric strength of air and oil. Full description of the method of testing and analysis of results. Characteristic curves of the dielectric strength of air and oil with different shaped electrodes, showing effect of duration of stress and of the energy behind the stress. Empirical equations.

Discussion, incorporated with that of H. W. Tobey's paper on "Dielectric Strength of Oil."

THE ELECTRIC STRENGTH OF AIR

J. B. Whitehead Vol. xxix—1910, pp. 1159-1187

Description and discussion of an experimental investigation of the dielectric strength of air and the formation of corona around cylindrical conductors, showing effects of temperature, pressure, and dimensions and material of the wire in dielectric strength of air. Description of a new and very accurate method of testing dielectric strength of air about conductors. Bibliography.

Discussion, incorporated with that of H. W. Tobey's paper on "Dielectric Strength of Oil."

DIELECTRIC STRENGTH OF OIL

H. W. Tobey Vol. xxix—1910, pp. 1189-1207

Description of the properties of insulating oils and methods of testing and handling such oils. Tests showing effects of form of electrode, temperature and moisture on dielectric strength of oils, with characteristic curves. Analytical and experimental study of methods of drying and filtering oil.

Discussion (including that of paper by Messrs. Joseph L. R. Hayden and Charles P. Steinmetz on "Disruptive Strength with Transient Voltages," and Mr. J. B. Whitehead's paper on "The Electric Strength of Air"), pp. 1208-1232, by Messrs. D. B. Rushmore, V. Karapetoff, Percy H. Thomas, A. E. Kennelly, W. H. Pratt, E. E. F. Creighton, J. C. Lincoln, Charles F. Scott, Harris J. Ryan, R. D. Mershon, C. P. Steinmetz, John B. Whitehead and M. A. de Chatelain.

General comments on the results of the tests, with various suggested explanations of the phenomena of corona, and relation of diameter of the conductor and other factors to the apparent dielectric strength of air.

POTENTIAL STRESSES IN DIELECTRICS

Harold S. Osborne Vol. xxix—1910, pp. 1553-1581

General résumé of work done in developing graded insulation for cables with derivation of formulas and construction of various sets of curves from which the best designs for graded cables can be read directly. Analytical discussion of phenomena immediately preceding dielectric

breakdown—corona in solid dielectrics—giving opinions of many eminent authorities, followed by a suggested explanation which is checked by tests. Bibliography.

Discussion, pp. 1582-1624, by Messrs. J. B. Whitehead, Milton Franklin, A. E. Kennelly, W. S. Franklin, W. I. Middleton, Henry A. Morss, R. W. Atkinson, H. W. Fisher, Percy Thomas, C. J. Fechheimer, G. I. Rhodes, Armin Henry Pikler, C. P. Steinmetz, C. O. Mailloux, Tracy D. Waring, William A. Del Mar and H. S. Osborne.

General discussion of graded insulation as applied to cables, generators and transformers, and also of the phenomena that precede breakdown in solid dielectrics. Formulas and experimental results bearing on the design of insulation. Effect of grading on the maximum safe kilowatt capacity of cables.

5. ELECTRIC CONDUCTORS

LOCATING FAULTS IN UNDERGROUND DISTRIBUTION SYSTEMS

Henry G. Stott Vol. xviii—1901, pp. 829-833

Description of a compass method for quickly and accurately locating faults in power cables through which periodically reversed current is sent. Working drawings of the current reverser.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

SUBMARINE CABLE TESTING IN THE SIGNAL CORPS U. S. ARMY

Vol. xix—1902, pp. 685-695

General description of the electrical and mechanical specifications for Signal Corps cable and the tests which it must undergo. Change of insulation resistance with temperature treated in detail, and a chart given for reducing resistances to standard temperatures.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

THE OPERATION AND MAINTENANCE OF HIGH-TENSION UNDERGROUND SYSTEM

Philip Torchio Vol. xxii—1903, pp. 421-425

Brief remarks on the general subject. Record of cable troubles on The New York Edison Company lines. Connections of apparatus for breaking down defective insulation.

Discussion, incorporated with that of paper by H. G. Stott on "The Use of Automatic Means for Disconnecting Disabled Apparatus."

THE ELECTRICAL CONDUCTIVITY OF COMMERCIAL COPPER

Lawrence Addicks Vol. xxii—1903, pp. 695-702

Experimental study of the relation between chemical composition, mechanical strength, physical structure and conductivity of copper.

Discussion, p. 703, by Messrs. B. J. Arnold and F. J. Newbury.

Properties of standard copper conductors.

SAFETY DEVICES IN CENTRAL STATIONS AND SUBSTATIONS

Philip Torchio Vol. xxi—1903, pp. 417-423

Itemized list of expedients to be employed in large central station system to insure the maximum degree of reliability of service.

Discussion, incorporated with that of paper by Peter Junkersfeld on "Multiple Versus Independent Operation of Units and Central Stations."

PROTECTION OF CABLES FROM ARCS DUE TO THE FAILURE OF ADJACENT CABLES

W. G. Carlton Vol. xxiii—1904, pp. 471-474

Description of methods of isolating and fire-proofing cables in manholes.

Discussion, pp. 475-479, by Messrs. Ralph D. Mershon, W. F. Wells, H. C. Wirt, W. G. Carlton, H. B. Alverson, E. M. Lake, A. M. Hunt and J. W. F. Blizard.

General remarks on the protection of high-tension cables in manholes and in power houses. Formulas for fire-proof coverings.

HIGH-POWER SURGES IN ELECTRIC DISTRIBUTION SYSTEMS OF GREAT MAGNITUDE

Charles P. Steinmetz Vol. xxiv—1905, pp. 297-315

Theoretical and mathematical investigation of high-power surge in Manhattan Railway cable distribution system.

Discussion, incorporated with paper by Percy H. Thomas on "An Experimental Study of the Rise of Potential on Commercial Transmission Lines Due to Static Disturbances caused by Switching, Grounding, Etc."

DATA RELATING TO ELECTRIC CONDUCTORS AND CABLES

H. W. Fisher Vol. xxiv—1905, pp. 397-414

Experimental study of the safe current-carrying capacity of insulated wires and cables. Effect of steel strands on cable impedance and method of overcoming it. Table of reactances for different sizes of wire and cables at different spacings. Tests of variation of insulation resistance and electrostatic capacity with temperature and of the heating of cables in ducts.

Discussion, pp. 415-419, by Messrs. H. G. Stott, C. W. Rice, C. O. Mailloux, Charles P. Steinmetz and H. W. Fisher.

Conditions under which high-reactance cable is desirable.

STANDARDIZING RUBBER-COVERED WIRES AND CABLES

John Langan Vol. xxv—1906, pp. 191-204

Protest against potential test as a criterion of insulation. Characteristics and properties of different grades of rubber, with instructions for easily determining the quality of rubber insulation. Suggested specifications for rubber-covered wires.

Discussion, incorporated with paper by Wallace S. Clark on "Comments on Present Underground Cable Practice."

COMMENTS ON PRESENT UNDERGROUND CABLE PRACTICE

Wallace S. Clark Vol. xxv—1906, pp. 205-213

Notes on electrolysis troubles with the low-tension cables. Effect of grounding sheath. Properties of insulation, tests of durability and record of operation of 11,000-volt 25-cycle rubber-covered leaded cables. Specifications of Rubber Covered Wire Engineers' Association for 30 per cent. rubber compound.

Discussion (included with paper by John Langan on "Standardizing

Rubber Covered Wires and Cables"), pp. 214-239, by Messrs. H. W. Fisher, H. G. Stott, Wallace D. Clark, John Langan, Philip Torchio, A. E. Kennelly, E. W. Stevenson, Townsend Wolcott, Durand Woodman, William McClellan, J. B. Taylor, C. F. Scott, S. S. Wheeler, Dugald C. Jackson, F. R. Cutcheon, J. H. Schumacher, H. J. Gille, John Pearson and E. H. Scofield.

General discussion of the requirements of rubber insulation and the methods of fixing and testing them. Results of tests on rubber insulated wires showing effect of percentage of Para on the performance characteristics under different conditions and indicating the method of determining the quality of insulation.

UNDERGROUND TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY

Charles E. Phelps — Vol. xxvi—1907, pp. 25-30

Classification of cable faults, followed by seven-year record of the performance of various kinds of power, telephone and telegraph cables. Brief analytical discussion of the causes and remedies for these various faults.

No discussion.

CONSTANTS OF CABLES AND MAGNETIC CONDUCTORS

Ernst J. Berg — Vol. xxvi—1907, pp. 555-568

Derivation of equations for inductance and capacity of parallel conductors, followed by an analysis of single-conductor cable performance under various conditions. Estimated effective resistance and reactance with grounded and ungrounded sheath and with iron armor; also estimated effective resistance of iron wire and cable.

Discussion, p. 926, by Mr. W. A. Del Mar.

Exact formula for inductance of parallel wires.

THE HEATING OF COPPER WIRES BY ELECTRIC CURRENTS

A. E. Kennelly and E. R. Shepard — Vol. xxvi—1907, pp. 969-995

Experimental investigation of the heating of wires under various conditions of cooling by thermal conduction—through insulation, sand, water and molding. Much data on thermal resistivity of insulation materials, wood and various soils. Graphical diagrams of the current carrying capacity of different sized wires under the various conditions.

No discussion.

POWER-FACTOR, ALTERNATING-CURRENT INDUCTIVE CAPACITY, CHEMICAL, AND OTHER TESTS OF RUBBER-COVERED WIRES OF DIFFERENT MANUFACTURERS

Henry W. Fisher — Vol. xxvi—1907, pp. 997-1020

Experimental investigation tending to show the relations that exist between the chemical composition of the rubber compound and the electrical properties of the wire—breakdown e. m. f., insulation resistance,

capacity, power-factor, and dielectric loss. Full results and test data are given in form of tables and graphical charts.

Discussion, pp. 1021-1025, by Messrs. Henry W. Fisher, Charles P. Steinmetz, E. W. Stevenson and Henry G. Stott.

General remarks on dielectric properties of cables.

CONDUCTOR RAIL MEASUREMENTS

S. B. Fortenbaugh Vol. xxvii—1908, pp. 1215-1229

Results of tests on Metropolitan District Railway third and fourth rail conductors, giving leakage and insulation difficulties under various conditions of service; also complete data on resistance tests made on conductor rails.

No discussion.

HIGH-POTENTIAL UNDERGROUND TRANSMISSION

P. Junkersfeld and E. O. Schweitzer Vol. xxvii—1908, pp. 1499-1527

Description of the underground cable system of the Commonwealth Edison Company of Chicago with records of its performance and results of experiments to determine the magnitude and frequency of occurrence of potential rises in the system.

Discussion, pp. 1528-1569, by Messrs. L. A. Ferguson, Charles H. Merz, H. W. Fisher, H. G. Stott, E. J. Berg, Wallace S. Clark, Alex Dow, Warren Partridge, E. E. F. Creighton, L. T. Robinson, Henry Floy, John W. Lieb, Jr., Philip Torchio, Charles P. Steinmetz, E. O. Schweitzer, Peter Junkersfeld, Ralph D. Mershon, H. W. Peck, A. E. Kennelly, N. J. Neall, L. L. Elden, M. V. Ayres, G. W. Palmer, Jr., and Dugald C. Jackson.

Cable experience of various large central stations and transmission companies.

THE CONVECTION OF HEAT FROM SMALL COPPER WIRES

A. E. Kennelly, C. A. Wright and J. S. Bylevelt Vol. xxviii—1909, pp. 363-393

Experimental investigation of convection from wires—varying diameter, air pressure and wind velocity.

Discussion, pp. 394-397, by Messrs. V. Karapetoff, Charles P. Steinmetz, Charles F. Scott, Paul M. Lincoln and A. E. Kennelly.

Remarks on nomenclature for absolute units.

RESISTANCE AND REACTANCE OF ARMORED CABLES

J. B. Whitehead Vol. xxviii—1909, pp. 737-746

Calculation and tests of effective impedance and reactance of single and double-conductor iron and copper-armored cable under various conditions of current density, spacing, interconnection of armor and sheathing, etc.

Discussion, incorporated with that of Mr. H. W. Fisher's paper on "Losses, Induced Volts and Amperes in Armor and Lead Cover of Cables."

LOSSESS, INDUCED VOLTS AND AMPERES IN ARMOR AND LEAD COVER OF CABLES

H. W. Fisher Vol. xxviii—1909, pp. 747-765

Tests of impedance, reactance, resistance and induced current and volts in the sheath and armor of single-conductor iron-armored, copper-armored and steel-tape armored cables, showing the effect of spacing, current density, cross-bonding of sheath and armor, etc. Graphical method of calculating the performance of such cables.

Discussion, pp. 766-767, including the discussion of Mr. J. B. Whitehead's paper on "Resistance and Reactance of Armored Cables," by Messrs. Ralph D. Mershon, H. W. Fisher, John B. Whitehead and Charles P. Steinmetz.

General discussion of the advisability of using single-conductor cables in alternating-current power transmission.

POTENTIAL STRESSES IN DIELECTRICS

Harold S. Osborne Vol. xxix—1910, pp. 1553-1581

General résumé of work done in developing graded insulation for cables with derivation of formulas and construction of various sets of curves from which the best designs for graded cables can be read directly. Analytical discussion of phenomena immediately preceding dielectric breakdown—corona on solid dielectrics—giving opinions of many eminent authorities, followed by a suggested explanation which is checked by tests. Bibliography.

Discussion, pp. 1582-1624, by Messrs. J. B. Whitehead, Milton Franklin, A. E. Kennelly, W. S. Franklin, W. I. Middleton, Henry A. Morss, R. W. Atkinson, H. W. Fisher, Percy Thomas, C. J. Fechheimer, G. I. Rhodes, Armin Henry Pikler, C. P. Steinmetz, C. O. Mailloux, Tracy D. Waring, William A. Del Mar and H. S. Osborne.

General discussion of graded insulation as applied to cables, generators and transformers, and also of the phenomena that precede breakdown in solid dielectrics. Formulas and experimental results bearing on the design of insulation. Effect of grading on the maximum safe kilowatt capacity of cables.

6. MAGNETIC PROPERTIES AND TESTING OF IRON

THE FACTORS WHICH AFFECT THE ENERGY LOSSES IN ARMATURE CORES

J. Walter Esterline and C. E. Reid — Vol. xxii—1903, pp. 445-460

Description of apparatus for experimental investigation of armature core losses. Analysis of core losses and results of tests showing effect of teeth, core section, solid poles, laminated poles and other factors on such losses.

Discussion, pp. 461-466, by Messrs. J. W. Esterline, Henry Pickler, W. E. Goldsborough, W. S. Franklin, Leonard Wilson, C. O. Mailloux and A. E. Kennelly.

Effect of number of poles and of pole arc upon armature core losses.

MAGNETIC PROPERTIES OF ELECTROLYTIC IRON

F. C. Burgess and A. Hoyt Taylor — Vol. xxv—1906, pp. 459-465

Some chemical and physical properties of electrolytic iron. Method and results of step by step magnetization and hysteresis tests.

Discussion, pp. 466-471, by Messrs. E. F. Northrup, D. C. Jackson, Chas. F. Scott, W. L. R. Emmett, C. P. Steinmetz, C. F. Burgess and R. A. Fessenden.

Magnetic alloys that do not contain iron.

THE EFFECT OF IRON IN DISTORTING ALTERNATING-CURRENT WAVE FORM

Frederick Bedell and Elbert B. Tuttle — Vol. xxv—1906, pp. 671-691

Theoretical investigation of the relation between the third harmonic introduced by iron in the exciting current and the hysteresis loop. Also, an exposition of the relation between the area of the hysteresis loop and the angle of hysteresis advance.

Discussion, pp. 692-714, by Messrs. Chas. P. Steinmetz, Philip Torchio, W. S. Franklin, Frederick Bedell, Harold Pender, A. Henry Pikler, S. P. Grace, H. B. Tuttle, S. N. Kintner and A. W. Copley.

Full discussion of wave distortion due to iron, showing that other harmonics than the third modify Professor Bedell's conclusions. References to early work of Huguet, Froelich, Kennelly, Gerosa, Finzi, Eickemeyer and Steinmetz.

Effect of wave distortion with different polyphase transformer connections. Derivation of the parabolic law of magnetic induction. Oscillograms of induced e. m. f. showing effect of primary impedance on wave form in core loss tests and in transformers.

THE TESTING OF TRANSFORMER STEEL

M. G. Lloyd and J. V. S. Fisher — Vol. xxviii—1909, pp. 439-467

Conditions and requirements of the wattmeter method of core-loss testing, with description of Bureau of Standards modification of Epstein

apparatus. Analysis of core losses and results of tests on large variety of transformer steels.

Discussion, pp. 468-473, by Messrs. L. T. Robinson, V. Karapetoff, C. E. Skinner, J. C. Lincoln, Clayton H. Sharp, Andrew Pinkerton, E. E. F. Creighton and M. G. Lloyd.

Discussion of the relative value of Bureau of Standards method and the Epstein method for commercial testing. Relation of magnetizing current to transformer regulation.

CALCULATION OF IRON LOSSES IN DYNAMO ELECTRIC MACHINERY

I. E. Hanssen **Vol. xxviii—1909, pp. 993-1001**

Experimental study of stream lines in various types of armatures, with a simple method for pre-determining the total iron loss.

Discussion, pp. 1002-1004, by Messrs. R. E. Hellmund, A. E. Averett, V. Karapetoff and I. E. Hanssen.

Remarks on the accuracy of the author's method.

POLE-FACE LOSSES

C. A. Adams, A. C. Lanier, C. C. Pope and C. O. Schooley **Vol. xxviii—1909, pp. 1133-1156**

Theoretical and experimental investigation of pole-face losses, establishing quantitative relations between such losses and the principal variables for both solid and laminated pole shoes. Comparison of calculated losses with test values.

No discussion.

7. BATTERIES

THE NEW EDISON STORAGE BATTERY

Arthur E. Kennelly — Vol. xviii—1901, pp. 219-230

Description of the battery, its advantages and mechanical construction. Performance data obtained from Mr. Edison.

Discussion, pp. 231-246, by Messrs. A. E. Kennelly, N. S. Keith, Charles P. Steinmetz, Robert McA. Lloyd, Carl Hering, C. O. Mailloux, H. G. Stott, Justus Entz, Charles J. Reed and H. E. Heath.

Principal disadvantages of the nickel-iron cell. Further performance data.

THE STORAGE BATTERY AS A FACTOR IN SPEED CONTROL

H. P. Coho — Vol. xx—1902, pp. 135-138

Brief description of electric drive for Hoe printing press, using storage battery for multi-voltage.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous Current Motors for Machine Tools."

POINT OF CUT-OFF IN A BATTERY DISCHARGE

Carl Hering — Vol. xix—1902, pp. 325-331

Considerations which enter into the determination of proper point of cut-off of discharge for primary and secondary batteries. Graphical solution. Typical discharge curves for constant current, constant resistance and constant power.

Discussion, incorporated with that of paper by W. R. Whitney on "Colloids."

STORAGE-BATTERY INDUSTRIAL LOCOMOTIVES

F. L. Sessions — Vol. xxii—1903, pp. 109-123

General discussion of storage-battery locomotives—their advantages; methods of operating the battery; calculation of battery rating for given service; motor control, etc. Tables for facilitating the calculation of storage-battery rating, with numerical example illustrating their use.

Discussion, pp. 124-131, by Messrs. Edgar H. Berry, F. L. Sessions and Elmer A. Sperry.

General remarks on storage-battery performance in industrial locomotive service, and criticisms of author's tables.

THE STORAGE-BATTERY IN SUBSTATIONS

W. E. Goldsborough and P. E. Fansler — Vol. xxvii—1909, pp. 243-277

Description of Indiana Union Traction Company distribution system. Account and results of tests showing the efficiency of the various parts

of the system, the performance and requirements of storage batteries in sub-stations. Graphic records of battery performance.

Discussion, incorporated with that of paper by Clarence Renshaw on "Some Notes on the Operation of Railway Motors in Service."

THE COMPARATIVE BEHAVIOR OF FLOATING AND BOOSTER-CONTROLLED BATTERIES ON FLUCTUATING LOADS

Lamar Lyndon Vol. xxii—1903, 705-731

Analysis of the performance of an electric railway plant with storage battery arranged in the following ways: Floating battery in station; floating battery on line; battery and booster on line; battery on the line and booster in the station. Numerical examples and comparison of the merits of different systems.

Discussion, pp. 732-734, by Messrs. J. R. Appleton, J. L. Woodbridge, W. E. Goldsborough, J. W. Lieb, Jr., W. W. Donaldson, A. S. Hubbard, F. L. Flanders and H. Etheridge.

Lead batteries for high discharge rates. E. m. f. characteristic of Edison battery under rapid discharge.

ON THE CALCULATION OF LINE BATTERIES

W. E. Winship Vol. xxiii—1904, pp. 393-402

Outline of method of determining the size and location of battery floating on railway distribution system under various conditions of service.

Discussion, pp. 457-459, by Messrs. F. J. White, Lamar Lyndon and W. E. Winship.

Practical importance of battery resistance in calculation of line batteries.

APPLICATION OF STORAGE BATTERIES TO REGULATION OF ALTERNATING-CURRENT SYSTEMS

J. L. Woodbridge Vol. xxvii—1908, pp. 987-1021

Brief general discussion of the various types of service where storage batteries can be used to regulate the alternating-current load, including brief descriptions of some typical plants. Detailed description of the use of storage batteries with carbon regulator, split-pole converter and synchronizing exciter, with analysis of performance. Analysis and oscillograms of e. m. f. waves of three-part and two-part pole converters. A general solution for the e. m. f. wave form of two-part pole converter.

Discussion (including paper by Comfort A. Adams on "Voltage Ratio in Synchronous Converters, with Special Reference to the Split-Pole Converter"), pp. 1022-1055, by Messrs. P. M. Lincoln, A. S. Hubbard, W. L. Waters, Chas. P. Steinmetz, J. L. Burnham, J. L. Woodbridge and G. E. Brown.

General discussion of the performance characteristics of the split-pole converter, with physical exposition of the method of varying the voltage ratio and its effect on armature reaction, heating and commutation. Data from tests in commercial operation.

THE APPLICATION OF STORAGE BATTERIES TO THE REGULATION OF THE ALTERNATING-CURRENT LOAD AT THE PLANT OF THE INDIANA STEEL COMPANY, GARY, INDIANA

J. Lester Woodbridge Vol. xxviii—1909, pp. 851-866

Description, theory and results of batteries used in connection with split-pole converters and synchronous exciters for regulation of alternating-current circuits.

Discussion, pp. 867-868, by Messrs. Edward Van Wagenen and J. L. Woodbridge.

Characteristics of synchronous exciter.

8. TRANSFORMERS

THE TRANSFORMER FOR MEASURING LARGE DIRECT CURRENTS

Harris J. Ryan Vol. xviii—1901, pp. 169-183

Description of the theory of operation, the design and construction of the transformer. Account of tests demonstrating the degree of accuracy under various conditions, such as occur in testing switchboard instruments in place.

Discussion, pp. 184-190, by Messrs. Geo. T. Hanchett, Gano S. Dunn, Samuel Sheldon, A. E. Kennelly, C. O. Mailloux and Townsend Wolcott.

Criticism of the method and answers thereto.

Y AND Δ CONNECTION OF TRANSFORMERS

F. O. Blackwell Vol. xxii—1903, pp. 385-389

Discussion of relative advantages of star and delta connection of transformers upon the construction of the transformers, the operation of transformers with neutral grounded, and rises of potential in star and T-connected transformers.

Discussion, pp. 390-416, by Messrs. J. S. Peck, C. F. Scott, R. F. Hayward, M. H. Gerry, Jr., V. G. Converse, P. N. Nunn, P. H. Thomas, P. M. Lincoln, Peter Junkersfeld, A. L. Mudge, J. E. Woodbridge and Louis Bell.

Comprehensive discussion of maximum possible strains with various single-phase and polyphase transformer connections for single and double transformations with grounded and ungrounded neutral. Dangers that may arise from operation with grounded neutral. Experience in operation of high-tension system with and without grounded neutral.

THE RELATIVE FIRE-RISK OF OIL AND AIR-BLAST TRANSFORMERS

E. W. Rice, Jr. Vol. xxiii—1904, pp. 171-173

Discussion, pp. 175-197, 236-238 and 246, by Messrs. F. A. C. Perrine, J. S. Peck, Calvert Townley, Ralph D. Mershon, C. E. Skinner, H. G. Stott, P. N. Nunn, P. M. Lincoln, C. L. de Muralt, O. S. Lyford, Jr., Howard Bayne, W. L. Waters, Irving A. Taylor, Norman T. Wilcox, A. C. Pratt, H. A. Lardner, H. F. Parshall, R. S. Kelsch, H. W. Tobey, William J. Hazard, E. P. Roberts, W. S. Moody, James Lyman, W. A. Blanck, P. Junkersfeld, G. N. Eastman, D. W. Roper, G. H. Lukes, W. G. Carlton, and J. W. Farley.

General discussion of the relative fire hazard of air-blast and oil immersed transformers. Combustion and explosive properties of oil. Experience with fires involving oil immersed and air-blast transformers. Methods of installing transformers so as to reduce fire risk to a minimum.

TERMINALS AND BUSHINGS FOR HIGH-PRESSURE TRANSFORMERS

Walter S. Moody

Vol. xxiii—1904, pp. 225-230

Location, arrangement and insulation of transformer terminals.

Discussion, pp. 231-235, by Messrs. Ralph D. Mershon, C. E. Skinner, Irving A. Taylor, N. M. Snyder and A. C. Pratt.

General remarks on transformer terminals and terminal bushings. Weak spots in construction of transformer terminals, taps and bushings. Bushing treated as a condenser.

THE USE OF GROUND-SHIELDS IN TRANSFORMERS

J. S. Peck

Vol. xxiii—1904, pp. 553-554

Description of the nature and purpose of the ground shield and list of objections to its use.

Discussion, pp. 555-556, by Messrs. Ralph. D. Mershon, H. C. Wirt, C. E. Skinner, P. H. Thomas and W. L. Waters.

Objections to ground shield. Advantages of grounded neutral.

THE CURRENT TRANSFORMER

Kenneth L. Curtis

Vol. xxv—1906, pp. 715-726

Method of predetermining the performance of series transformer from tests of exciting current and internal losses. Method of measuring small inductances.

Discussion, pp. 727-734, by Mr. L. T. Robinson.

Testing of series transformer for ratio and phase angle. Oscillograms of exciting current of series transformers.

RELATIVE MERITS OF THREE-PHASE AND ONE-PHASE TRANSFORMERS

H. W. Tobey

Vol. xxvi—1907, pp. 813-815

Brief general remarks.

Discussion, incorporated with paper by John S. Peck on "Relative Advantages of One-Phase and Three-Phase Transformers."

RELATIVE ADVANTAGES OF ONE-PHASE AND THREE-PHASE TRANSFORMERS

John S. Peck

Vol. xxvi—1907, pp. 817-821

Classification and discussion of relative advantages and disadvantages of three-phase and bank of three single-phase transformers.

Discussion (including that of paper by H. W. Tobey on "Relative Merits of Three-Phase and One-Phase Transformers"), pp. 822-834, by Messrs. Peter Junkersfeld, R. F. Schuchardt, C. W. Stone, Walter S. Moody, W. B. Jackson, P. M. Lincoln, Edward A. Wagner, A. H. Pikler, E. N. Lake, H. B. Gear, A. S. McAllister, W. F. Lamme, K. C. Randall and D. L. Huntington.

Experience with three-phase transformers. Relative advantages of shell and core-type three-phase transformers with regard to repairs.

FORCED-OIL AND FORCED-WATER CIRCULATION FOR COOLING OIL-INSULATED TRANSFORMERS

C. C. Chesney Vol. xxvi—1907, pp. 835-839

Brief description of forced-oil method of cooling transformers, giving the saving in cost. Diagram of piping connections.

Discussion, pp. 837-850, by Messrs. C. W. Stone, W. S. Moody, A. Henry Pikler, W. B. Jackson, P. M. Lincoln, S. M. Kintner, A. H. Babcock, M. C. Canfield, G. Percy Cole, D. L. Huntington, W. F. Lamme, William McClellan, A. L. Mudge and Calvert Townley.

Relative advantages of forced-water and forced-oil cooling. Characteristics of oil as a cooling agent. Illustrated description of forced-oil plant.

CHOKE-COILS VERSUS EXTRA INSULATION ON THE END-WINDINGS OF TRANSFORMERS

S. M. Kintner Vol. xxvi—1907, pp. 1169-1172

Brief statement of the purpose of the choke-coil, followed by a list of advantages and disadvantages incident to its use, both inside and outside the transformer case.

Discussion, incorporated with paper by H. W. Tobey on "Notes on Transformer Testing."

PROTECTION OF THE INTERNAL INSULATION OF A STATIC TRANSFORMER AGAINST HIGH-FREQUENCY STRAINS

Walter S. Moody Vol. xxvi—1907, pp. 1173-1178

Illustrated description of a method of protecting transformers by providing extra insulation on the end turns and bringing out the taps from the center of the winding.

Discussion, incorporated with paper by H. W. Tobey on "Notes on Transformer Testing."

NOTES ON TRANSFORMER TESTING

H. W. Tobey Vol. xxvi—1907, pp. 1179-1189

Brief general instructions for testing transformers so as to determine their chief characteristics—ratio, polarity, resistance, copper losses, core losses, exciting current, regulation, insulation, high potential and heating.

Discussion (including that of paper by S. M. Kintner on "Choke-Coils Versus Extra Insulation on the End-Windings of Transformers," and paper by Walter S. Moody on "Protection of the Internal Insulation of a Static Transformer Against High-Frequency Strains"), pp. 1190-1208, by Messrs. S. M. Kintner, A. H. Pikler, P. M. Lincoln, J. W. Fraser, W. N. Smith, Charles W. Stone, E. E. F. Creighton, William McClellan, W. S. Lee, R. P. Jackson, Charles P. Steinmetz, Ralph D. Mershon, D. B. Rushmore, W. LeRoy Emmet, O. S. Lyford, Jr., H. W. Buck, W. S. Moody, H. W. Tobey, E. J. Berg, B. C. Shipman, Frank G. Baum, A. C. Pratt, James Lyman and Farley Osgood.

General remarks on the protective value of choke coils, their location and insulation, and on the use of extra insulation on the end turns of transformers, either with or without choke coils.

TESTS WITH ARCING GROUNDS AND CONNECTIONS

Ernst J. Berg Vol. xxvii—1908, pp. 741-751

Account of tests with arcing grounds on transformers with single-phase and polyphase connections to study the effect of such grounds under various conditions and indicate the best methods of protecting transformers.

Discussion, incorporated with paper by Percy H. Thomas on "Critical Study of Lightning Records on Taylor's Falls Transmission Line."

A TRIGONOMETRIC METHOD FOR THE SOLUTION OF ALTERNATING-CURRENT PROBLEMS

Harold Pender Vol. xxvii—1908, pp. 1397-1424

Development of a short method for solving alternating-current problems with examples of its application to single-phase and three-phase transmission lines, transformer and induction motors. Tables of reactance capacity, resistance and drop factors for use in such calculations.

Discussion, pp. 1424-1427, by Messrs. Comfort A. Adams, W. A. Del Mar and L. W. Rosenthal.

Magnitude of errors involved by this method when applied to transmission line calculations.

HIGH-VOLTAGE TRANSFORMERS AND PROTECTIVE AND CONTROLLING APPARATUS FOR OUTDOOR INSTALLATION

K. C. Randall Vol. xxviii—1909, pp. 189-207

Description of types of apparatus, with estimates of relative costs of outdoor and indoor installations. Operation of outdoor transformer stations.

Discussion, incorporated with that of A. B. Reynders' paper on "Condenser Type of Insulation for High-Tension Terminals."

CONDENSER TYPE OF INSULATION FOR HIGH-TENSION TERMINALS

A. B. Reynders Vol. xxviii—1909, pp. 209-220

Theory, construction and tests of special form of high-tension terminal bushing built with alternate layers of metal foil and insulation.

Discussion, pp. 221-268, including that of K. C. Randall's paper on "High-Tension Transformers and Protective and Controlling Apparatus for Outdoor Installation," by Messrs. W. S. Moody, Percy H. Thomas, David B. Rushmore, Paul M. Lincoln, E. M. Hewlett, S. Piek, Guido Semenza, A. E. Kennelly, J. S. Peck, Ralph D. Mershon, W. S. Franklin, N. J. Neall, G. Faccioli, C. L. de Muralt, V. D. Moody, M. W. Franklin, A. B. Reynders, Ralph W. Pope, F. G. Baum, O. S. Lyford, Jr., Carl

Schwartz, J. B. Whitehead, John J. Frank, W. L. Waters, L. L. Perry, J. N. Kelman, August H. Kruesi, and D. Kos.

General discussion of the advisability of using outdoor transformer and switching stations. Experience with outdoor high-tension apparatus. Theory and calculation of condenser type bushings. Construction of oil and asphalt filled insulating bushings.

METHOD OF TESTING TRANSFORMER CORE LOSSES GIVING SINE WAVE RESULTS ON COMMERCIAL CIRCUITS

L. W. Chubb Vol. xxviii–1909, pp. 417-431

The use, construction and limits of accuracy of a special instrument—iron-loss voltmeter—consisting of a wattmeter connected in series by an exciting winding on a steel core and calibrated to read the impressed voltage of sine wave e. m. f. Also a description of a method of adjusting form factor in core-loss tests.

Discussion, pp. 432-438, by Messrs. Frederick Bedell, Charles P. Steinmetz, M. G. Lloyd, L. T. Robinson, Charles F. Scott and L. W. Chubb.

General discussion of the use and limitations of iron-loss voltmeter. Description of a method for obtaining sine wave from a commercial circuit.

THE TESTING OF TRANSFORMER STEEL

M. G. Lloyd and J. V. S. Fisher Vol. xxviii—1909, pp. 439-467

Conditions and requirements of the wattmeter method of core-loss testing, with description of Bureau of Standards modification of Epstein apparatus. Analysis of core losses and results of tests on large variety of transformer steels.

Discussion, pp. 468-473, by Messrs. L. T. Robinson, V. Karapetoff, C. E. Skinner, J. C. Lincoln, Clayton H. Sharp, Andrew Pinkerton, E. E. F. Creighton and M. G. Lloyd.

Discussion of the relative value of Bureau of Standards method and the Epstein method for commercial testing. Relation of magnetizing current to transformer regulation.

EVEN HARMONICS IN ALTERNATING-CURRENT CIRCUITS

John B. Taylor Vol. xxviii–1909, pp. 725-732

Description of conditions under which even harmonics may be produced in commercial circuits, with special reference to the effect of stray direct current on the performance of stationary transformers. Tests and oscillograms of transformer exciting current with stray direct current in the windings.

Discussion, pp. 733-736, by Messrs. Frederick Bedell, V. Karapetoff, Charles F. Scott, Charles P. Steinmetz and John B. Taylor.

Production of even harmonics in alternators and effect of direct current in the windings of a transformer upon the losses.

CORONA PHENOMENA IN AIR AND OIL AND THEIR RELATION TO TRANSFORMER DESIGN

W. S. Moody and G. Faccioli

Vol. xxviii—1909, pp. 769-798

Theoretical and experimental investigation of corona formation in apparatus of limited dimensions in air and in oil, showing the effect of character of surface, insulating masses, conductor masses, dimensions of conductor, etc.

Discussion, pp. 799-804, by Messrs. John B. Whitehead, J. C. Lincoln, Ralph D. Mershon, S. B. Charters, Jr., W. S. Moody and Harris J. Ryan.

Dielectric strength and conducting character of air. Mechanical strains due to corona under oil. Description of Ryan's corona voltmeter.

ELECTRICAL MEASUREMENTS ON CIRCUITS REQUIRING CURRENT AND POTENTIAL TRANSFORMERS

L. T. Robinson

Vol. xxviii—1909, pp. 1005-1039

Theoretical discussion of the effects of instrument transformers on the accuracy of ammeter and wattmeter measurements, together with tables of correction factors for phase angle error in power measurements. Theory of operation of series transformer showing effects of variation in frequency, secondary impedance, line current, power-factor and wave form. Description of methods of testing series and shunt instrument transformers with ratio and phase-angle performance curves from actual test.

Discussion, pp. 1040-1052, by Messrs. C. H. Sharp, M. G. Lloyd, L. W. Chubb, J. Dalemont, Albert F. Ganz and L. T. Robinson.

Methods of measuring ratio and phase angle of current transformers and correction factor for instrument transformers in polyphase measurements.

SOME PHASES OF TRANSFORMER REGULATION

W. A. Hillebrand and S. B. Charters, Jr.

Vol. xxviii—1909, pp. 1253-1267

Experimental study of effect of phase and voltage unbalance on transformer regulation, using different systems of connection.

Discussion, pp. 1268-1278, by Messrs. F. E. Giebel, W. F. Lamme, B. G. Lamme, J. W. White, S. G. Gassaway, C. L. Gory, F. V. T. Lee, H. C. Holberton and W. A. Hillebrand.

General discussion of the effects of voltage unbalance on power apparatus and measuring instruments connected to transformers.

OBSERVATION OF HARMONICS IN CURRENT AND IN VOLTAGE WAVE SHAPES OF TRANSFORMERS

John J. Frank

Vol. xxix—1910, pp. 809-890

Experimental investigation and analysis of the wave form of transformer currents and e. m. f. for single-phase and polyphase connections, showing the practical signification of wave distortion in transformer

operation. Methods of wave analysis fully explained and 176 oscillograms shown.

Discussion, pp. 891-903, by Messrs. H. J. Ryan, G. Faccioli, W. A. Hillebrand, C. A. Copeland, L. B. Stillwell, C. L. Cory, Silvanus P. Thompson, Edmund C. Stone, C. Fortescue, C. A. Adams and J. J. Frank.

General remarks on the causes and effects of wave distortion in transformers. Analysis of hysteresis loops and additional explanations of the results of Mr. Frank's tests.

DISRUPTIVE STRENGTH WITH TRANSIENT VOLTAGES

Joseph L. R. Hayden and Charles P. Steinmetz — Vol. xxix—1910, pp. 1125-1158

Account of experimental investigation of the effects of time and energy on the dielectric strength of air and oil. Full description of the method of testing and analysis of results. Characteristic curves of the dielectric strength of air and oil with different shaped electrodes, showing effect of duration of stress and of the energy behind the stress. Empirical equations.

Discussion, incorporated with that of H. W. Tobey's paper on "Dielectric Strength of Oil."

DIELECTRIC STRENGTH OF OIL

H. W. Tobey — Vol. xxix—1910, pp. 1189-1207

Description of the properties of insulating oils and methods of testing and handling such oils. Tests showing effects of form of electrode, temperature, and moisture on dielectric strength of oils, with characteristic curves. Analytical and experimental study of methods of drying and filtering oil.

Discussion, pp. 1208-1232, including that of paper by Messrs. Joseph L. R. Hayden and Charles P. Steinmetz on "Disruptive Strength with Transient Voltages," and Mr. J. B. Whitehead's paper on "The Electric Strength of Air," by Messrs. D. B. Rushmore, V. Karapetoff, Percy H. Thomas, A. E. Kennelly, W. H. Pratt, E. E. F. Creighton, J. C. Lincoln, Charles F. Scott, Harris J. Ryan, R. D. Mershon, C. P. Steinmetz, John B. Whitehead and M. A. de Chatelain.

General comments on the results of the tests, with various suggested explanations of the phenomena of corona, and relation of diameter of the conductor and other factors to the apparent dielectric strength of air.

DETERMINATION OF TRANSFORMER REGULATION UNDER LOAD CONDITIONS AND SOME RESULTING INVESTIGATIONS

Adolph Shane — Vol. xxix—1910, pp. 1281-1294

Description of a method of measuring directly transformer regulation, also a method of direct determination of the transformer impedance triangle. Full account of tests made to establish the accuracy of the methods.

Discussion, pp. 1295-1302, by Messrs. Charles Fortescue, E. A. Wagner L. T. Robinson, Ralph W. Atkinson and Adolph Shane.

Objections to the author's methods. Modifications of the author's methods.

SOME RECENT DEVELOPMENTS IN EXACT ALTERNATING-CURRENT MEASUREMENTS

Clayton H. Sharp and William W. Crawford **Vol. xxix—1910, pp. 1517-1541**

Description of design and construction of various precision devices—synchronous reversing key, adjustable mutual inductance, phase shifter and heavy current non-inductive shunt—showing their application in the accurate measurement of ratio and phase angle of series and shunt instrument transformers and in an alternating-current potentiometer.

Discussion, pp. 1542-1552, by Messrs. V. Karapetoff, L. T. Robinson, W. H. Pratt, C. P. Steinmetz, Clayton H. Sharp and William W. Crawford.

General remarks on precision measurements of alternating-current quantities. Description of a water-cooled electrodynamometer, also of a method of measuring very high frequency alternating current.

9. ELECTRIC MACHINERY

A. DIRECT-CURRENT MACHINES

NOTES ON MODERN ELECTRIC RAILWAY PRACTICE

Albert H. Armstrong Vol. xviii—1901, pp. 589-601

Consideration of the requirements of different classes of electric railway service leading up to a discussion of the relative merits of direct-current series and induction motors for interurban and trunk line operation.

Discussion, incorporated with that of paper by Ernst J. Berg on "Electric Railway Apparatus."

A VARIABLE RELUCTANCE METHOD OF MOTOR SPEED CONTROL

G. Fred Packard Vol. xix—1902, pp. 1131-1141

Reference to earliest work in this direction. Description of the Johnson method of varying the reluctance at the pole face, while maintaining the commutating fringe. Performance tests and flux distribution curves of a Stow motor built on these principles.

Discussion, pp. 1142-1143, by Messrs. Chas. P. Steinmetz, William Esty, G. Fred Packard, P. H. Thomas and E. B. Raymond.

THREE-WIRE SYSTEM FOR VARIABLE SPEED MOTOR WORK

N. W. Storer Vol. xx—1902, pp. 127-133

Description of the operation of adjustable speed motors from three-wire generator, giving advantages of the system and the range of speed variation when combined field and armature control are used.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous Current Motors for Machine Tools."

CONTINUOUS-CURRENT MOTORS FOR MACHINE TOOLS

F. O. Blackwell Vol. xx—1902, pp. 159-165

Power characteristics and requirements of various classes of machine tools. Brief mention of the different methods of speed control of electric motors and the advantages and limitations of each.

Discussion (including that of paper by R. T. E. Lozier on "The Operation of Machine Shops by Individual Electric Motors"; paper by N. W. Storer on "Three-Wire System for Variable Speed Motor Work"; paper by H. B. Coho on "The Storage Battery as a Factor in Speed Control"; paper by P. O. Keilholtz on "Electrically Operated Coal Hoist Having Variable Speed Control"; paper by Geo. W. Fowler on "A Series-Parallel System of Speed Control;" and paper by H. Ward Leonard on "Multiple-Unit, Voltage Speed Control for Trunk Line Service"), pp. 166-195, by Messrs. Gano S. Dunn, Chas. F. Scott, H. E. Heath, S. T. Dodd,

Arthur Williams, Philip Lange, Chas. Day, R. T. E. Lozier, N. W. Storer, H. Ward Leonard, Herbert Dowe, H. B. Coho, Geo. A. Damon, R. W. Stovel, Geo. B. Dusinberre, W. A. Dick, P. M. Lincoln, W. L. Campbell, Chas. G. Winslow, E. M. Tingley, ——— Stevenson, ——— Barr, R. H. Pierce, Peter Junkersfeld, O. E. Osthoff, D. C. Jackson, B. J. Arnold, G. B. Foster, Ernest Gonzenbach, V. R. Lansingh, H. H. Cutler, E. J. Pearson and H. R. King.

Relative merits of various methods of speed control of direct-current motors. Conditions which determine the choice between individual and group drive. Effects of motor drive and suitable speed control on shop efficiency. Advantages and disadvantages of the Ward-Leonard system of locomotive driven from single-phase circuits.

METHODS OF SPEED CONTROL

Wm. Cooper — Vol. xx—1902, pp. 197-213

Outline of the general power requirements of the different classes of machine tools. Description of method of choosing proper size of motor for given service and speed range from a speed horse-power diagram for combining multiple-voltage and field regulation; numerical examples. Set of general rules for determining motor size.

No discussion.

THE FACTORS WHICH AFFECT THE ENERGY LOSSES IN ARMATURE CORES

J. Walter Esterline and C. E. Reid — Vol. xxii—1903, pp. 445-460

Description of apparatus for experimental investigation of armature core losses. Analysis of core losses and results of tests showing effect of teeth, core section, solid poles, laminated poles and other factors of such losses.

Discussion, pp. 461-466, by Messrs. J. W. Esterline, Henry Pikler, W. E. Goldsborough, W. S. Franklin, Leonard Wilson, C. O. Mailloux and A. E. Kennelly.

Effect of number of poles and of pole arc upon armature core losses.

PRE-DETERMINATION OF SPARKING IN DIRECT-CURRENT MACHINES

W. L. Waters — Vol. xxiii—1904, pp. 365-378

Early methods of designing commutator machines, followed by development of sparking constant for different types of series and shunt-wound machines.

Discussion, incorporated with that of paper by E. H. Anderson on "Effect of Self-Induction on Railway Motor Commutation."

EFFECT OF SELF-INDUCTION ON RAILWAY MOTOR COMMUTATION

E. H. Anderson — Vol. xxiii—1904, pp. 379-391

Experimental study of commutation with oscillographic records of pressures between commutator segments under various conditions and of

potential rise in field and armature windings due to interruption and restoration of power at free running speeds.

Discussion (including that of paper by W. L. Waters on "Predetermination of Sparking in Direct-Current Machines"), pp. 443-457, by Messrs. W. L. Waters, E. R. Douglas, R. B. Treat, Thorburn Reid, E. H. Anderson, W. S. Franklin, Clarence P. Feldman and H. Ward Leonard.

General remarks on commutation reaction and predetermination of the limitation of commutation.

LIMITS OF INJURIOUS SPARKING IN DIRECT-CURRENT COMMUTATION

Thorburn Reid Vol. xxiv—1905, pp. 611-642

Mathematical investigation of destruction of commutator surface based on the theory that all injury results from contact surface energy due to current density and sliding friction. Equations for determining maximum energy density and maximum temperature rise. Derivation of equations given in the appendix.

Discussion, pp. 643-648, by Messrs. Gano S. Dunn, Charles P. Steinmetz, W. L. Waters, Thorburn Reid and J. N. Dodd.

General remarks on contact energy theory of damage done by commutation.

LIMITATIONS IN DIRECT-CURRENT MACHINE DESIGN

Sebastian Sentius Vol. xxiv—1905, pp. 689-712

Development of a system of design based upon experimental data and commercial guarantees, with investigation of the limits imposed by commutation difficulties.

Discussion, pp. 713-716, by Messrs. Gano S. Dunn, W. L. Waters, Charles P. Steinmetz and Sebastian Sentius.

Actual limits in size of direct-current machines. Factors which modify author's conclusions.

DIRECT-CURRENT MOTOR DESIGN AS INFLUENCED BY THE USE OF THE INTERPOLE

C. H. Bedell Vol. xxv—1906, pp. 329-339

Flux distribution curves taken from interpole motors. Some factors in the design of interpoles and advantages from their use.

Discussion, pp. 340-348, by Messrs. H. F. T. Erben, C. H. Bedell, W. L. Waters, N. J. Neall, S. Sentius, S. S. Wheeler, David Hall, L. D. Nordstrum and Chas. P. Steinmetz.

General remarks on the advantages of interpoles on constant and adjustable speed shunt motors, turbo-generators and series railway motors.

COMMUTATING-POLE DIRECT-CURRENT RAILWAY MOTORS

E. H. Anderson Vol. xxvi—1907, pp. 1407-1417

Brief review of troubles encountered in the design of railway motors, leading up to commutation which is treated more in detail. Theory of

action of commutating poles in series motor and possibilities as to voltage and service capacity which it introduces into direct-current railway engineering.

Discussion, pp. 1418-1419, by Messrs. Gano Dunn, J. C. Lincoln, E. H. Anderson and W. N. Smith.

Flashing and creeping distances on 600-volt ordinary and 1200-volt commutating pole railway motors.

CHARACTERISTICS OF MOTORS FOR LARGE SHEARS

Brent Wiley **Vol. xxvii—1908, pp. 321-334**

Discussion of the characteristics of different types of direct-current and alternating-current motors for driving large bloom shears, with actual load curves and full data of the machines tested.

No discussion.

CALCULATION OF IRON LOSSES IN DYNAMO ELECTRIC MACHINERY

I. E. Hanssen **Vol. xxviii—1909, pp. 993-1001**

Experimental study of stream lines in various types of armatures, with a simple method for predetermining the total iron loss.

Discussion, pp. 1002-1004, by Messrs. R. E. Hellmund, A. E. Averett, V. Karapetoff and I. E. Hanssen.

Remarks on the accuracy of the author's method.

POLE-FACE LOSSES

C. A. Adams, A. C. Lanier, C. C. Pope and C. O. Schooley **Vol. xxviii—1909, pp. 1133-1156**

Theoretical and experimental investigation of pole-face losses, establishing quantitative relations between such losses and the principal variables for both solid and laminated pole shoes. Comparison of calculated losses with test values.

No discussion.

ACYCLIC (HOMOPOLAR) DYNAMOS

J. E. Noeggerath **Vol. xxiv—1905, pp. 1-18**

Theory of operation of various types of homopolar generators with brief description of the design features, the construction and the performance characteristics of an actual turbo-homopolar generator.

Discussion, pp. 19-27, by Messrs. F. B. Crocker, A. E. Kennelly, C. Cartwright, F. V. Henshaw, J. E. Noeggerath, H. E. Heath, W. H. Pratt, G. H. Stickney and C. M. Green.

General remarks on the advantages and limitations of the homopolar generator.

B. SYNCHRONOUS MACHINES

ELECTRIC RAILWAY APPARATUS

Ernst J. Berg

Vol. xviii—1901, pp. 603-630

Discussion of the characteristics and limitations of generators, converters, motor-generators and motors for different kinds of electric railway service. Extended consideration of the relative merits of direct-current series, and polyphase induction motors in a given numerical instance, comparing performance, efficiency and cost.

Discussion (including that of paper by Albert H. Armstrong on "Notes on Modern Electric Railway Practice"), pp. 631-666, by Messrs. Paul Janet, Chas. P. Steinmetz, G. Gillon, Chas. Janisch, Bion J. Arnold, C. O. Mailloux, E. P. Roberts, L. B. Stillwell, A. H. Pott, C. F. Scott, P. K. Stern, H. C. Spaulding, F. S. Holmes, Ernst J. Berg, A. H. Armstrong and N. C. Sawers.

General remarks on the stability of the induction motor for traction purposes.

PARALLEL RUNNING OF ALTERNATORS

Ernst J. Berg

Vol. xviii—1901, pp. 753-757

Development of equation covering the principles of parallel operation of alternators, showing the effect of armature reaction, the cause of hunting and remedy.

Discussion, incorporated with that of paper by W. I. Slichter on "Angular Velocity in Steam Engine in Relation to Paralleling of Alternators."

A METHOD OF COMPOUNDING ALTERNATING-CURRENT GENERATORS AND MOTORS, DIRECT-CURRENT GENERATORS, SYNCHRONOUS MOTOR-GENERATORS AND SYNCHRONOUS CONVERTERS

Frank George Baum

Vol. xix—1902, pp. 745-757

Description of original methods of compounding alternating-current generators, synchronous motors, direct-current generators, synchronous converters, synchronous motor generators and transmission systems. Use of the Baum regulation diagram.

Discussion, incorporated with that of paper by Chas. P. Steinmetz on "Notes on the Theory of the Synchronous Motor."

NOTES ON THE THEORY OF THE SYNCHRONOUS MOTOR

Chas. P. Steinmetz

Vol. xix—1902, pp. 781-801

Development of the phase characteristics of the synchronous motor, followed by analytical investigation of electro-mechanical resonance or surging and the conditions which determine the stability of a synchronous motor.

Discussion (including that of paper by Frank George Baum on "A Method of Compounding Alternating-Current Generators and Motors, Direct-Current Generators, Synchronous Motor-Generators and Synchronous Converters"; paper by M. LeBlanc on "Formula for Calculating

the Electromotive Force at Any Point of a Transmission Line for Alternating Current"; and paper by H. W. Buck on "The New Generating Plants of the Niagara Falls Power Company"), pp. 802-808 and 1210, by Messrs. F. A. C. Perrine, F. G. Baum, C. A. Adams, H. W. Buck, A. V. Garratt, P. H. Thomas, Chas. P. Steinmetz and B. A. Behrend.

Results of tests with Baum's compensator for compound excitation of alternators, design data for the compensator. General discussion of switchboard arrangement.

AN EXPERIMENT WITH SINGLE-PHASE ALTERNATORS ON POLYPHASE CIRCUITS

C. O. Mailloux

Vol. xix—1902, pp. 851-861

Description of tests made on the lines of the Phoenix Light and Fuel Company, Arizona, to determine the suitability of operating single-phase generator in each phase of a polyphase system, and of producing a polyphase system with single-phase generators, and a synchronous converter as balancer.

Discussion, pp. 862-864, by Messrs. C. P. Steinmetz, W. B. Potter, C. O. Mailloux, H. E. Heath and John Murphy.

General remarks on this method of operation. Experience with two-phase converter operated from single-phase generator.

ENERGY LOSS IN COMMERCIAL INSULATING MATERIALS WHEN SUBJECTED TO HIGH POTENTIAL STRAINS

Charles Edward Skinner

Vol. xix—1902, pp. 1047-1062

Experimental study of energy losses in dielectrics, showing the effects of variation in voltage, temperature, moisture and frequency. The exact nature of the dielectric not given. Test of energy losses in 5,000-kilowatt engine-type alternator of Manhattan Railway Company.

Discussion (including that of paper by Percy H. Thomas on "The Function of Shunt and Series Resistance in Lightning Arresters," and paper by Miles Walker on "Electrostatic Wattmeter in Commercial Measurements"), pp. 1063-1073, by Edw. L. Nichols, Chas. F. Hopewell, Chas. E. Skinner, W. S. Andrews, F. A. C. Perrine, Elihu Thomson, William Maver, Jr., P. B. Woodworth, C. P. Steinmetz and P. H. Thomas.

Observed dielectric strength of mica under oil. Electrolytic conduction in cable insulation. Effect of moisture on dielectric strength of oil. General remarks on lightning arresters.

THE DETERMINATION OF ALTERNATOR CHARACTERISTICS

Louis A. Herdt

Vol. xix—1902, pp. 1093-1121

Analytical and experimental study of alternator characteristics with description of different methods for determining regulation. Results of calculations checked with tests on inductor and revolving field types of machines. Diagrams of the magnetic circuits of the machines tested, and many test curves of load and saturation characteristics, flux distribution, etc.

No discussion.

THE EXPERIMENTAL BASIS FOR THE THEORY OF THE REGULATION OF ALTERNATORS

B. A. Behrend Vol. xxi—1903, pp. 497-517

Experimental study of regulation of alternators indicating an approximate method of determining the regulation from the combination of the Behn-Eschenburg or e. m. f. method and the Institute or ampere-turn method.

THE COMPOUNDING OF SELF-EXCITED ALTERNATING-CURRENT GENERATORS FOR VARIATION IN LOAD AND POWER-FACTOR

A. S. Garfield Vol. xxi—1903, pp. 569-577

Description of the compounding and compensating characteristics of the Latour self-exciting alternator with brushes in different positions on both inductive and non-inductive loads.

Discussion, pp. 578-587, by Messrs. C. F. Scott, B. A. Behrend, C. A. Adams, Gano S. Dunn, W. L. Waters, J. R. Armstrong, Marius Latour, P. M. Lincoln, V. Karapetoff, ——— Schmit, J. S. Peck and E. Molin.

General remarks on importance of specifying regulation and on methods of estimating it. Latour method of compounding alternators.

COMMERCIAL ALTERNATOR DESIGN

W. L. Waters Vol. xxii—1903, pp. 39-57

Practical discussion of the economic design of revolving field alternators. Numerical examples used to demonstrate the quantitative effect of various factors that enter into the design. Comparison of the design constants and cost of present-day alternators with those of ten years ago.

Discussion, pp. 58-62, by Messrs. W. L. Waters, David B. Rushmore, Ralph D. Mershon, and Harris J. Ryan.

Effects of various degrees of regulation. Desirability of standardizing regulation at zero, instead of unity power-factor.

THE MECHANICAL CONSTRUCTION OF REVOLVING-FIELD ALTERNATORS

David B. Rushmore Vol. xxiii—1904, pp. 253-290

Comprehensive review of the constructive details of modern alternating-current generators. Profusely illustrated with working drawings and sketches covering practically all types of construction.

Discussion, incorporated with that of paper by H. M. Hobart and F. Punga on "A Contribution to the Theory of the Regulation of Alternators."

A CONTRIBUTION TO THE THEORY OF THE REGULATION OF ALTERNATORS

H. M. Hobart and F. Punga Vol. xxiii—1904, pp. 291-322

Theoretical investigation of armature reaction in single-phase and polyphase generator. Development of method of calculating the regulation and excitation from the design constants of the machine. Actual tests of

accuracy of the method in given instances. Complete design data given for the machines tested. Derivation of all new formulas.

Discussion (including that of paper by David B. Rushmore on "The Mechanical Construction of Revolving-Field Alternators"), pp. 323-343, by Messrs. C. A. Adams, Jr., B. A. Behrend, W. L. Waters, Gano S. Dunn, David B. Rushmore, F. A. C. Perrine, Bradley T. McCormick, V. Karapetoff, H. M. Hobart and Franklin Punga.

Discussion of analytical and graphical methods of calculating exciting current and regulation from design data and experimental data.

OPERATION OF SYNCHRONOUS CONVERTERS

S. C. Lindsay **Vol. xxiii—1904, pp. 345-351**

Account of experience with the parallel operation of 60-cycle synchronous converter, where much trouble was experienced from hunting.

No discussion.

DATA AND TESTS ON A 10,000-CYCLE-PER-SECOND ALTERNATOR

B. G. Lamme **Vol. xxiii—1904, pp. 417-428**

Description of construction of machines, covering mechanical and electrical features. Results of tests plotted as curves showing the performance of the machine at different frequencies—saturation curves, iron losses, short-circuit current, friction and windage.

Discussion, pp. 459-460, by Mr. F. D. Newbury.

Method of measurements in 10,000-cycle generator tests.

SYNCHRONOUS MOTORS FOR REGULATION OF POWER-FACTOR AND LINE PRESSURE

B. G. Lamme **Vol. xxiii—1904, pp. 481-492**

Discussion of factors which enter into the design of synchronous motor for power-factor regulation. Application of synchronous motors as regulators and as combined motor and regulator. General remarks on power-factor regulation, use of synchronous converters, cost of synchronous motor regulation, choice of location of regulator, etc.

Discussion, pp. 494-510, by Messrs. F. O. Blackwell, W. L. Waters, H. B. Gear, W. B. Jackson, F. A. C. Perrine, Ralph D. Mershon, S. B. Storer, Charles F. Scott, J. S. Peck, H. W. Buck and T. J. Johnston.

General remarks on power-factor and e. m. f. regulation with synchronous motors. Description of methods of automatically adjusting the excitation of the synchronous motor.

A SELF-EXCITING ALTERNATOR

E. F. Alexanderson **Vol. xxv—1906, pp. 61-77**

Description of a self-exciting compounding alternator which operates with rectifying commutator.

Discussion, pp. 78-80, by Messrs. A. E. Kennelly, F. C. Scott, W. L. R. Emmett, A. S. McAllister and E. F. Alexanderson.

SOME FEATURES AFFECTING THE PARALLEL OPERATION OF SYNCHRONOUS MOTOR-GENERATOR SETS

J. B. Taylor

Vol. xxv—1906, pp. 113-13

Analysis of phenomena causing unequal division of load between synchronous motor-generator sets, with requirements in design, construction and operation necessary to overcome these difficulties. Tests showing magnitude and character of unbalanced conditions. Detailed directions for starting synchronous motor-generator sets.

Discussion, pp. 137-138, by Messrs. W. L. Waters and J. B. Taylor.

Experience in parallel operation of synchronous motor-generator sets.

HEAT TESTS OF ALTERNATORS

Sebastian Sentius

Vol. xxv—1906, pp. 311-325

Analytical discussion of various methods of making heat tests of alternators without facilities for full-load output. Author proposes method that can be used on machines having equal numbers of poles or equal layers of parallel windings.

Discussion, pp. 326-327, by Dr. C. P. Steinmetz.

Approximate heat tests of alternators of any type.

THE SELF-SYNCHRONIZING OF ALTERNATORS

Morgan Brooks and M. K. Akers

Vol. xxv—1906, pp. 453-458

Synchronizing with impedance and reactance coils.

No discussion.

INTRODUCTION TO DISCUSSION ON THE PRACTICABILITY OF LARGE GENERATORS WOUND FOR 22,000 VOLTS

B. A. Behrend

Vol. xxvi—1907, pp. 351-356

Brief outline of some of the difficulties encountered in the construction of high voltage generators. Performance curves taken from 150-kilowatt, 22,000-volt alternator.

Discussion, pp. 357-385, by Messrs. B. A. Behrend, C. E. Skinner, W. S. Murray, A. H. Armstrong, W. L. Waters, Percy H. Thomas, Philip Torchio, F. V. Henshaw, C. F. Scott, Paul M. Lincoln, Ralph D. Mershon, F. G. Baum, Ernst J. Berg, W. J. Foster, R. S. Kelsch, L. Schuler, Farley Osgood, H. F. Parshall, A. Henry Pikler, Bertrand P. Rowe, A. B. Reynders, Guido Semenza and John Pearson.

Advantages and disadvantages of high-voltage generators. Experience with some high-voltage machines. Comparative costs of high and low-voltage alternators.

INTERACTION OF SYNCHRONOUS MACHINES

Morgan Brooks

Vol. xxvi—1907, pp. 1027-1046

Development of a circle diagram for representing the physical relations and quantities of ideal synchronous machines in parallel operation.

Mathematical analysis of the problem and expressions for the input, output, losses, efficiency and synchronizing power.

Discussion, pp. 1047-1048, by Messrs. E. J. Berg, Charles P. Steinmetz and Comfort A. Adams.

Practical limitations of Professor Brook's method. Origin of the circle diagram used in the paper.

THE GROUNDED NEUTRAL, WITH AND WITHOUT SERIES RESISTANCE, IN HIGH-TENSION SYSTEMS

Paul M. Lincoln — Vol. xxvi—1907, pp. 1585-1595

General discussion of the advantages and disadvantages of the grounded neutral, followed by brief remarks on the making of grounds and the effect of series resistance in the ground circuit.

Discussion, incorporated with paper by George I. Rhodes on "Experience with a Grounded Neutral on the High-Tension System of the Interborough Rapid Transit Company."

EXPERIENCE WITH A GROUNDED NEUTRAL ON THE HIGH-TENSION SYSTEM OF THE INTERBOROUGH RAPID TRANSIT COMPANY

George I. Rhodes — Vol. xxvi—1907, pp. 1605-1610

Reasons for installing grounded neutral with series resistor on high-tension cable system. Cross currents between star-connected generators. Relative damage resulting from cable short circuits with and without grounded neutral.

Discussion (including that of paper by Paul M. Lincoln on "The Grounded Neutral, with and without Series Resistance, in High-Tension Systems," and that of paper by F. G. Clark on "The Grounded Neutral"), pp. 1611-1641, by Messrs. Peter Junkersfeld, Philip Torchio, N. J. Neall, John B. Taylor, Carl Schwarz, C. W. Stone, F. B. H. Paine, Charles F. Scott, Paul M. Lincoln, George I. Rhodes, Charles P. Steinmetz, Frank G. Baum, and O. S. Lyford, Jr.

Experience with grounded neutral on very large underground cable and overhead transmission systems. Description of device for automatically selecting and disconnecting defective cables.

A NEW LARGE GENERATOR FOR NIAGARA FALLS

B. A. Behrend — Vol. xxvii—1908, pp. 1057-1068

Photographs, drawings and brief description of the design and construction of a 10,000-h.p. 300-r.p.m. generator. Brief outline of theory of stresses in rotating disks and rings.

Discussion, incorporated with paper by Jens Bache-Wiig on "Application of Fractional Pitch Windings to Alternating-Current Generators."

MODERN DEVELOPMENT IN SINGLE-PHASE GENERATORS

W. L. Waters Vol. xxvii—1908, pp. 1069-1076

Brief general discussion of difficulties in the design of large single-phase turbo-generators, due to pulsation of armature reaction and to mechanical stresses on end connections when carrying short-circuit current.

Discussion, incorporated with paper by Jens Bache-Wiig on "Application of Fractional Pitch Windings to Alternating-Current Generators."

APPLICATION OF FRACTIONAL PITCH WINDINGS TO ALTERNATING-CURRENT GENERATORS

Jens Bache-Wiig Vol. xxvii—1908, pp. 1077-1085

Brief general outline of the advantages of the fractional pitch winding with respect to utilization of copper and space and to facilitation of manufacture, followed by a short discussion of its effect on armature reaction and wave form.

Discussion (including paper by B. A. Behrend on "A New Large Generator for Niagara Falls," and paper by W. L. Waters on "Modern Development in Single-Phase Generators"), pp. 1086-1097, by Messrs. Wm. J. Foster, B. A. Behrend, L. Schuler, F. H. Clough, Chas. P. Steinmetz and W. L. Waters.

General remarks on the design of single-phase turbo-alternators and comments on the mechanical design of 10,000-h.p. high-speed generators.

THE RELATIVE PROPORTIONS OF COPPER AND IRON IN ALTERNATORS

Carl J. Fechheimer Vol. xxvii—1908, pp. 1429-1458

Analytical study of the costs and weights of materials in alternators, expressing the various factors in the form of equations and solving for minimum cost. Example comparing calculations from equations with calculations from actual dimensions.

Discussion, pp. 1457-1458, by Messrs. W. L. Waters and Comfort A. Adams.

ALTERNATOR FOR 100,000 CYCLES

E. F. W. Alexanderson Vol. xxviii—1909, pp. 399-415

Description of the mechanical design and electrical characteristics of a high-frequency alternator.

Discussion, pp. 413-415, by Messrs. John B. Taylor, J. C. Lincoln, David B. Rushmore, C. J. Fechheimer, and A. E. Kennelly.

Further description of the mechanical and electrical operative characteristics of the 100,000-cycle generator.

COMPARATIVE COSTS OF 25-CYCLE AND 60-CYCLE ALTERNATORS

Carl J. Fechheimer Vol. xxviii—1909, pp. 975-989

Theoretical analysis of the cost of material and construction of 25 and 60-cycle alternators of ratings up to 6,500 kw.

Discussion, pp. 990-991, by Messrs. J. C. Lincoln, M. G. Lloyd and Carl J. Fechheimer.

Relation between armature copper and field copper and rating of alternators.

ELECTROMOTIVE FORCE WAVE SHAPE IN ALTERNATORS

Comfort A. Adams **Vol. xxviii—1909, pp. 1053-1076**

Description of a method of calculating wave shape of e. m. f. from flux distribution curve, with tables of correction factors for various types of windings. Examples indicating the relation of winding type to wave shape.

Discussion, p. 1077, by Messrs. J. C. Lincoln and Comfort A. Adams.

Choice of pitch to eliminate higher harmonics.

PARALLEL OPERATION OF THREE-PHASE GENERATORS, WITH THEIR NEUTRALS INTERCONNECTED

George I. Rhodes **Vol. xxix—1910, pp. 765-790**

Analytical development of the relations between the factors that produce neutral currents in star-connected generators with interconnected neutrals, so as to permit a close predetermination of the magnitude of the currents, followed by an application of the equation to existing generators, the results being checked by tests. Remedies for the prevention of these currents are suggested.

Discussion, pp. 791-807, by Messrs. H. J. Ryan, S. J. Lisberger, G. I. Rhodes, C. L. Cory, L. B. Stillwell, C. F. Adams, Paul Downing, E. F. Scattergood, W. F. Lamme, P. M. Lincoln, C. A. Adams, S. B. Charters, Jr., W. A. Hillebrand, Ralph D. Mershon, and H. Y. Hall.

Some experience with plants operating with star-connected generators with interconnected neutrals. Laboratory reproduction of these conditions. Feasibility of applying author's remedies.

C. INDUCTION MACHINES

THE INDUCTION MOTOR AND THE ROTARY CONVERTER AND THEIR RELATION TO THE TRANSMISSION SYSTEM

Chas. F. Scott **Vol. xviii—1901, pp. 371-382**

Detailed comparison of induction and synchronous motors as to construction, performance characteristics and operation. General discussion of synchronous converters, induction motor-generators and synchronous motor-generators, bringing out their relation to the generator.

Discussion, incorporated with that of paper by E. W. Rice, Jr., on "The Control of High-Voltage Systems of Large Power."

NOTES ON MODERN ELECTRIC RAILWAY PRACTICE

Albert H. Armstrong **Vol. xviii—1901, pp. 589-601**

Consideration of the requirements of different classes of electric railway service leading up to a discussion of the relative merits of direct-

current series and induction motors for interurban and trunk line operation.

Discussion, incorporated with that of paper by Ernst J. Berg on "Electric Railway Apparatus."

ELECTRIC RAILWAY APPARATUS

Ernst J. Berg Vol. xviii—1901, pp. 603-630

Discussion of the characteristics and limitations of generators, converters, motor-generators and motors for different kinds of electric railway service. Extended consideration of the relative merits of direct-current series, and polyphase induction motors in a given numerical instance, comparing performance, efficiency and cost.

Discussion (including that of paper by Albert H. Armstrong on "Notes on Modern Electric Railway Practice"), pp. 631-666, by Messrs. Paul Janet, Chas. P. Steinmetz, G. Gillon, Chas. Janisch, Bion J. Arnold, C. O. Mailloux, E. P. Roberts, L. B. Stillwell, A. H. Pott, C. F. Scott, P. K. Stern, H. C. Spaulding, F. S. Holmes, Ernst J. Berg, A. H. Armstrong, and N. C. Sawers.

General remarks on the stability of the induction motor for traction purposes.

A NOVEL COMBINATION OF POLYPHASE MOTORS FOR TRACTION PURPOSES

Ernst Danielson Vol. xix—1902, pp. 527-539

Description of a system of concatenating two motors of unequal numbers of poles so as to get four running speeds. Comparison of acceleration characteristics, torque, energy, efficiency, etc., with direct-current series, plain, induction and concatenated induction motors. Abstracted by Dr. Chas. P. Steinmetz on page 495.

Discussion (including that of paper by Carl L. DeMuralt on "Some Notes on European Practice in Electric Traction with Three-Phase Alternating Current"), pp. 540-555, by Messrs. C. P. Steinmetz, C. O. Mailloux, Henry G. Stott, W. N. Smith, W. J. Hammer, Townsend Wolcott, Frederick V. Henshaw, and C. L. DeMuralt.

THE SINGLE-PHASE INDUCTION MOTOR

William S. Franklin Vol. xxiii—1904, pp. 429-441

Physical analysis of the performance of the single-phase induction motor, with equations for the principal electrical factors. Application of the Heyland diagram to the single-phase motor.

Discussion, pp. 466-469, by Messrs. W. S. Franklin and A. S. McAllister.

Criticisms of Steinmetz's method of dealing with the single-phase induction motor. Test showing effect on exciting current of disconnecting one phase of the two-phase motor.

THE DESIGN OF INDUCTION MOTORS

Comfort A. Adams — Vol. xxiv—1905, pp. 649-684

Exposition of a method of calculating the leakage factors of an induction motor and expressing the power-factor in terms of design constants and the exciting current in terms of the torque current. Numerical examples of the application of these methods to actual motors.

Discussion, pp. 685-687, by Messrs. W. L. Waters, Charles P. Steinmetz and Comfort A. Adams.

Actual degree of accuracy in induction motor construction. Degree of accuracy necessary in design.

EDDY CURRENTS IN LARGE SLOT-WOUND CONDUCTORS

A. B. Field — Vol. xxiv—1905, pp. 761-788

Theoretical investigation of the I^2R losses caused by eddy currents in conductors imbedded in slots. Loss constants given for various arrangements with different shaped slots with solid and laminated conductors.

No discussion.

ALTERNATE-CURRENT MACHINERY-INDUCTION ALTERNATORS

William Stanley Assisted by G. Faccioli — Vol. xxiv—1905, pp. 851-872

Description of induction generators excited with alternating current of frequency differing from that of mechanical rotation. Mode of operation giving theory of e. m. f. regulation, followed by regulation curves from actual tests. Determination of size of exciter and description of type of exciter suitable for obtaining proper e. m. f. characteristics at very low frequencies.

Discussion, pp. 873-877, by Messrs. Charles P. Steinmetz, Comfort A. Adams and W. E. Goldsborough.

Explanation of the mode of operation by considering the machine a frequency converter.

AIR-GAP FLUX IN INDUCTION MOTORS

A. S. Langsdorf — Vol. xxiv—1905, pp. 919-931

Theoretical and mathematical study of the effect upon flux distribution of varying the number of stator teeth, the exciting current assumed to be a sine wave.

Discussion, pp. 932-933, by Messrs. B. A. Behrend, Fitzhugh Townsend, A. H. Pikler, and A. S. Langsdorf.

Criticisms of the assumptions made by the author.

COMPARISON OF TWO AND THREE-PHASE MOTORS

Bradley McCormick — Vol. xxv—1906, pp. 295-306

Comparison of design constants of two induction machines of the same rating and built on equal frames—one two-phase and the other three-phase.

Discussion, pp. 307-309, by Messrs. A. S. McAllister, Bradley McCormick, C. P. Steinmetz, and R. E. Hellmund.

Calculation of exciting current from volume of core and air-gap.

FRACTIONAL PITCH WINDINGS FOR INDUCTION MOTORS

C. A. Adams, W. K. Cabot and G. AE. Irving, Jr., **Vol. xxvi—1907, pp. 1485-1503**

Derivation of formulas for various leakage reactances—slot, tooth tip, coil end and belt, followed by actual tests, the results of which are plotted as curves.

Discussion, incorporated with paper by R. E. Hellmund on "Zigzag Leakage of Induction Motors."

ZIGZAG LEAKAGE OF INDUCTION MOTORS

R. E. Hellmund **Vol. xxvi—1907, pp. 1505-1524**

Definitions and derivations of formulas for magnetic leakage coefficients of induction motors, leading up to the formula for light-load zigzag leakage coefficient. General discussion of the subject. Effect of fractional pitch winding on excitation of induction motors.

Discussion (including that of paper by C. A. Adams, W. K. Cabot and G. AE. Irving, Jr., on "Fractional Pitch Windings for Induction Motors"), pp. 1525-1526, by Messrs. J. C. Lincoln, Charles P. Steinmetz, B. T. McCormick, Comfort A. Adams, and A. S. McAllister.

THE NON-SYNCHRONOUS GENERATOR IN CENTRAL STATION AND OTHER WORK

W. L. Waters **Vol. xxvii—1908, pp. 157-180**

General characteristics of induction generator; method of operation; methods of excitation; regulation; behavior on short-circuits; advantages in connection with steam turbine and gas engine drive.

Analytical discussion of its suitability to different kinds of service—large and small central stations and in the production of direct current with steam turbines.

Discussion, incorporated in paper by J. E. Woodbridge on "Some Features of Railway Converter Design and Operation."

CALCULATION OF THE STARTING TORQUE OF SINGLE-PHASE INDUCTION MOTORS WITH PHASE-SPLITTING STARTING DEVICES

I. E. Hanssen **Vol. xxvii—1908, pp. 373-375**

No discussion.

INDUCTION MOTORS FOR MULTI-SPEED SERVICE, WITH PARTICULAR REFERENCE TO CASCADE OPERATION

H. C. Specht **Vol. xxvii—1908, pp. 1177-1195**

Analytical and experimental investigation of performance and characteristics of a Cascade set arranged for direct and differential concatenation.

Discussion, pp. 1196-1212, by Messrs. W. I. Slichter, A. E. Averett, Elmer A. Sperry, and H. C. Specht.

Relation between effectiveness of concatenation and magnitude of speed range. Description of several compensated Cascade sets.

THE HEATING OF INDUCTION MOTORS

A. Miller Gray — Vol. xxviii—1909, pp. 527-553

Theoretical and experimental investigation of heating of induction motors when starting and while running, showing its effect upon design. Data on thermal conductivity, convection and radiation which are of general value in design of electric machinery.

Discussion, pp. 554-558, by Mr. David Hoock.

A TRIGONOMETRIC METHOD FOR THE SOLUTION OF ALTERNATING-CURRENT PROBLEMS

Harold Pender — Vol. xxvii—1908, pp. 1397-1424

Development of a short method for solving alternating-current problems with examples of its application to single-phase and three-phase transmission lines, transformer and induction motors. Tables of reactance capacity, resistance and drop factors for use in such calculations.

Discussion, pp. 1424-1427, by Messrs. Comfort A. Adams, W. A. Del Mar and L. W. Rosenthal.

Magnitude of errors involved by this method when applied to transmission line calculations.

REDUCTION IN CAPACITY OF POLYPHASE MOTORS DUE TO UNBALANCING IN VOLTAGE

S. B. Charters, Jr., and W. A. Hillebrand — Vol. xxviii—1909, pp. 559-575

Experimental study of the effect of unbalanced e. m. f. and phase shift on output of induction and synchronous motors.

Discussion, pp. 576-586, by Messrs. R. E. Hellmund, A. E. Averett, A. M. Dudley, John C. Parker, Charles P. Steinmetz, Charles F. Scott, H. L. Wallau, S. B. Charters, Jr., I. E. Hanssen, and W. E. Hillebrand.

THE CURRENT LOCUS OF THE SINGLE-PHASE INDUCTION MOTOR

A. S. Langsdorf — Vol. xxviii—1909, pp. 587-598

Theoretical discussion of a method of calculating the exact secondary current locus for single-phase induction motors.

Discussion, pp. 599-600, by Messrs. V. Karapetoff and A. S. Langsdorf.

Teaching the theory of the single-phase induction motor.

MULTI-SPEED INDUCTION MOTORS

H. G. Reist & H. Maxwell — Vol. xxviii—1909, pp. 601-609

Theoretical discussion of methods of varying speeds of induction motors by changing the number of poles, the change of poles being accomplished

by regrouping the coils, by use of independent windings and by concatenation. Actual tests.

Discussion, pp. 610-614, by Messrs. H. C. Specht, A. M. Dudley, Charles P. Steinmetz, E. F. W. Alexanderson, A. E. Averett, and H. G. Reist.

General discussion of limitations of these methods of speed variation, and additional data on internal concatenation.

FUNCTION OF FLY-WHEELS IN CONNECTION WITH ELECTRICALLY OPERATED ROLLING MILLS

H. C. Specht

Vol. xxviii—1909, pp. 869-878

Theoretical analysis of the performance of induction motor rolling mill drive with varying amounts of fly-wheel effect. Numerical examples chosen to indicate the most economical combination for driving a given plate and rail mill.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

THE REQUIREMENTS FOR AN INDUCTION MOTOR FROM THE USER'S POINT OF VIEW

Walter B. Nye

Vol. xxix—1910, pp. 147-149

Brief mention of some of the conditions which must be met in the design of coils, bearings, shafts, pulleys and controllers so as to improve continuity of service and facilitate repairs.

Discussion (including that of paper by Mr. Dugald C. Jackson on "The Applicability of Electrical Power to Industrial Establishments;" Mr. Charles T. Main's paper on "Central Stations Versus Isolated Plants for Textile Mills;" Mr. R. S. Hale's paper on "The Supply of Electrical Power for Industrial Establishments from Central Stations," and Mr. G. H. Stickney's paper on "Illumination for Industrial Plants"), pp. 150-182, by Messrs. J. C. Parker, Charles B. Burleigh, Norman T. Wilcox, H. B. Emerson, N. W. Dalton, H. W. Peck, R. D. DeWolf, Albert L. Pearson, H. D. James, C. A. Graves, J. H. Gardiner, and H. D. Jackson.

General discussion of the relative advantages and disadvantages of central stations and private plant energy supply, together with figures and experience from actual practice. Brief description of decentralized system of electrical energy production in which moderate size non-condensing turbo-electric stations supply both electricity and steam to consumers, the stations being interconnected both by the electric and the steam distribution systems.

INTERACTION OF FLY-WHEELS AND MOTORS WHEN DRIVING ROLL TRAINS BY INDUCTION MOTORS

F. G. Gasche

Vol. xxix—1910, pp. 1385-1402

General discussion of the application of fly-wheels to roll mill drive, followed by mathematical analysis of the forces acting in an induction motor fly-wheel set when coupled to a roll train, with a full mathematical development of the equations.

Discussion, pp. 1403-1414, by Messrs. C. P. Steinmetz, C. F. Scott, Gano Dunn, Selby Haar, W. W. Crawford, and F. G. Gasche.

Short-cut methods of calculating the performance of fly-wheel induction motor drive for roll trains.

D. ALTERNATING-CURRENT COMMUTATOR MACHINES

A STUDY OF THE HEYLAND MACHINE AS MOTOR AND GENERATOR

Comfort A. Adams · Vol. xxi—1903, pp. 519-568

Outline of development of alternating-current commutator motor leading up to the Heyland machine. Principle and theory of operation of the Heyland motor. Tests of the performance characteristics of the machine as a motor, and as shunt and compound generator. Bibliography.

SPEED-TORQUE CHARACTERISTICS OF THE SINGLE-PHASE REPULSION MOTOR

Walter I. Slichter Vol. xxiii—1904, pp. 1-7

Observed and calculated performance characteristics of single-phase repulsion motor for railway service compared with direct-current series motor.

Discussion, incorporated with that of paper by Charles P. Steinmetz on "The Alternating-Current Railway Motor."

THE ALTERNATING-CURRENT RAILWAY MOTOR

Charles P. Steinmetz Vol. xxiii—1904, pp. 9-25

Brief account of early work with compensated series commutator single-phase motor. Design data given for motors built by Eickemeyer and actual performance characteristics of this motor compared with calculated performance of repulsion motor. Analytical theory of single-phase repulsion motor.

Discussion (including that of paper by Walter I. Slichter on "Speed-Torque Characteristics of the Single-Phase Repulsion Motor"), pp. 26-81, by Messrs. B. G. Lamme, A. S. McAllister, B. J. Arnold, Charles P. Steinmetz, P. M. Lincoln, W. I. Slichter, Ralph D. Mershon, A. H. Armstrong, Robert Lundell, O. S. Lyford, Jr., H. A. Wagner, Charles F. Scott, B. A. Behrend, W. S. Franklin, Dugald C. Jackson, and V. Karapetoff.

Theory of operation of compensated series and repulsion motors treated analytically and graphically. Observed performance characteristics of repulsion motor as motor and generator.

REPULSION INDUCTION MOTOR

Maurice Milch Vol. xxv—1906, pp. 269-290

Theory and performance characteristics of a commutator single-phase induction motor that starts as a repulsion motor.

Discussion, pp. 291-294, by Messrs. C. P. Steinmetz, D. C. Jackson and G. Percy Cole.

Some requirements of cotton mill drive.

THE SINGLE-PHASE COMMUTATOR TYPE MOTOR

B. G. Lamme

Vol. xxvii—1908, pp. 137-156

Brief discussion of certain features in the design of compensated single-phase series motors for railway service; covering effects of magnetic induction and frequency in commutation and torque; decrease of effective air gap; effect of power-factor on overload torque, etc.

No discussion.

THE VECTOR DIAGRAM OF THE COMPENSATED SINGLE-PHASE ALTERNATING-CURRENT MOTOR

W. I. Slichter

Vol. xxvi—1907, pp. 1527-1532

Physical theory and development of the diagram.

Discussion, p. 1533, by Mr. V. Karapetoff.

Effect of saturation on vector diagram.

A SINGLE-PHASE RAILWAY MOTOR

E. F. Alexanderson

Vol. xxvii—1908, pp. 1-17

Classification of single-phase railway motors, followed by theoretical analysis of the performance characteristic of a series-repulsion motor.

Discussion, pp. 18-42, by Messrs. L. B. Stillwell, B. G. Lamme, W. B. Potter, O. S. Lyford, Jr., W. I. Slichter, S. N. Kintner, Charles P. Steinmetz, W. S. Murray, E. F. Alexanderson, and Elmer A. Sperry.

General remarks on the relative merits of series-repulsion and compensated series motors, with considerable data on the actual performance of the compensated series motor as to power-factor, commutation, brush wear, etc.

A SKETCH OF THE THEORY OF THE ADJUSTABLE SPEED SINGLE-PHASE SHUNT INDUCTION MOTOR

F. Creedy

Vol. xxviii—1909, pp. 475-516

Theoretical discussion of methods of varying the speed of single-phase shunt repulsion motors, with results of tests.

Discussion, incorporated with that of paper by E. F. W. Alexanderson on "Repulsion Motor with Variable Speed Shunt Characteristics."

REPULSION MOTOR WITH VARIABLE SPEED SHUNT CHARACTERISTICS

E. F. W. Alexanderson

Vol. xxviii—1909, pp. 511-521

Theoretical discussion of method of speed control for a single-phase shunt repulsion motor.

Discussion, pp. 522-526, including discussion of F. Creedy's paper on "Adjustable Speed Single-Phase Shunt Induction Motors," by Messrs. V. Karapetoff, E. F. W. Alexanderson and F. Creedy.

Further remarks on the methods of speed variation of shunt repulsion motors, together with test data.

ON THE SPACE ECONOMY OF THE SINGLE-PHASE SERIES MOTOR

William S. Franklin and Stanley S. Seyfert **Vol. xxix—1910, pp. 23-40**

Theory and tests of a balanced choke coil arrangement for preventing excessive short-circuit currents due to pulsating flux; also description of a proposed single-phase commutator motor with external armature and commutator intended to give improved utilization of space.

Discussion, pp. 41-53, by Messrs. S. M. Kintner, E. H. Anderson, E. F. W. Alexanderson, S. S. Seyfert, L. B. Stillwell, and W. S. Franklin.

Detailed criticism of the external armature type motor tending to show its impracticability. Brief mention of other methods of improving space economy. Weight and space factors from actual practice.

E. CONVERTERS AND MOTOR-GENERATORS

THE INDUCTION MOTOR AND THE ROTARY CONVERTER AND THEIR RELATION TO THE TRANSMISSION SYSTEM

Chas. F. Scott **Vol. xviii—1901, pp. 371-382**

Detailed comparison of induction and synchronous motors as to construction, performance characteristics and operation. General discussion of synchronous converters, induction motor-generators and synchronous motor-generators, bringing out their relation to the generator.

Discussion, incorporated with that of paper by E. W. Rice, Jr., on "The Control of High-Voltage Systems of Large Power."

ELECTRIC RAILWAY APPARATUS

Ernst J. Berg **Vol. xviii—1901, pp. 603-630**

Discussion of the characteristics and limitations of generators, converters, motor-generators and motors for different kinds of electric railway service. Extended consideration of the relative merits of direct-current series, and polyphase induction motors in a given numerical instance, comparing performance, efficiency and cost.

Discussion (including that of paper by Albert H. Armstrong on "Notes on Modern Electric Railway Practice"), pp. 631-666, by Messrs. Paul Janet, Chas. P. Steinmetz, G. Gillon, Chas. Janisch, Bion J. Arnold, C. O. Mailloux, E. P. Roberts, L. B. Stillwell, A. H. Pott, C. F. Scott, P. K. Stern, H. C. Spaulding, F. S. Holmes, Ernst J. Berg, A. H. Armstrong, and N. C. Sawers.

General remarks on the stability of the induction motor for traction purposes.

ENERGY TRANSFORMATIONS IN THE SYNCHRONOUS CONVERTER

William S. Franklin

Vol. xxii—1903, pp. 17-33

Analysis of the energy relations in synchronous converters to determine the amount of energy which is conductively transferred from one circuit to the other, and the amount which is transferred inductively. Brief discussion of armature reaction.

Discussion, pp. 34-37, by Samuel Sheldon.

Criticism of Prof. Franklin's method.

CONSTANT-CURRENT MERCURY ARC RECTIFIER

Charles P. Steinmetz

Vol. xxiv—1905, pp. 371-393

Description of mercury arc rectifier system covering operative characteristics, performance tests with various kinds of load, and theory and calculation of the electrical constants.

Discussion, pp. 394-396, by Messrs. J. W. Lieb, Jr., John W. Howell, Percy H .Thomas, F. A. C. Perrine, E. F. Northrup, and Charles P. Steinmetz.

Criticism of rectification theory based on properties of arc. First description of rectification with mercury arc. Type of instruments suitable for measurement of rectified currents.

SYNCHRONOUS CONVERTERS AND MOTOR-GENERATORS

W. L. Waters

Vol. xxiv—1905, pp. 717-732

Comparative speeds, costs and efficiencies of synchronous converters for different voltages and ratings at 25 and 60 cycles. Discussion of operative characteristics of synchronous converters—e. m. f. control, commutation, armature reaction, heating, mounting and mechanical design.

Discussion, pp. 733-740, by Messrs. Gano S. Dunn, F. G. Proutt, Charles P. Steinmetz, L. C. Marburg, H. G. Stott, Morgan Brooks, J. W. Lieb, Jr., and W. L. Waters.

Advantages of induction motor in motor-generator sets. Effect of high armature reaction on surging. Operation of synchronous converters in parallel and their behavior under short circuit.

SHUNT AND COMPOUND-WOUND SYNCHRONOUS CONVERTERS FOR RAILWAY WORK

W. L. Waters

Vol. xxv—1906, pp. 549-553

Some advantages and disadvantages of compound wound synchronous converters.

Discussion, pp. 554-557, by Messrs. J. B. Taylor, P. M. Lincoln and W. L. Waters.

General remarks pro and con compound wound synchronous converters.

MOTOR GENERATORS VS. SYNCHRONOUS CONVERTERS

P. M. Lincoln — Vol. xxvi—1907, pp. 303-311

Brief general analysis of the relative merits of synchronous converters, synchronous motor generator and induction motor generator from operative and economical standpoints.

Discussion, pp. 312-349, by Messrs. A. H. Armstrong, W. L. Waters, H. G. Stott, Ralph D. Mershon, Charles W. Stone, Charles F. Scott, Philip Torchio, B. A. Behrend, J. R. C. Armstrong, A. H. Babcock, F. G. Baum, Ernst J. Berg, R. G. Black, Edward P. Burch, H. W. Buck, O. B. Coldwell, W. R. C. Corson, Henry Floy, Clarence E. Gifford, William B. Jackson, R. S. Kelsch, Farley Osgood, John C. Parker, H. F. Parshall, A. C. Pratt, Leo Schuler, Carl Schwartz, Guido Semenza, B. C. Shipman, Miles Walker, and J. B. Whitehead.

General discussion of the relative merits of the synchronous converter, the synchronous motor generator and the induction motor generator with regard to reliability, voltage regulation, efficiency, cost, etc.

SOME DEVELOPMENTS IN SYNCHRONOUS CONVERTERS

Chas. W. Stone — Vol. xxvii—1908, pp. 181-189

Description of some mechanical details of the vertical type synchronous converter. Brief discussion of the advantages and disadvantages of different methods of voltage regulation including the booster and the split-pole methods.

Discussion, incorporated with paper by J. E. Woodbridge on "Some Features of Railway Converter Design and Operation."

SOME FEATURES OF SYNCHRONOUS CONVERTER DESIGN AND OPERATION

J. E. Woodbridge — Vol. xxvii—1908, pp. 191-216

Analytical study of the three-phase and the six-phase synchronous converter, with a demonstration of the advantages of the self-starting converters and a discussion of the theory and practice of compounding.

Discussion (including paper by W. L. Waters on "The Non-Synchronous Generator in Central Station and Other Work," and paper by Chas. W. Stone on "Some Developments in Synchronous Converters"), pp. 217-254, by Messrs. C. F. Scott, Paul M. Lincoln, F. G. Clark, Chas. P. Steinmetz, Comfort A. Adams, J. R. Bibbins, Philip Torchio, J. B. Taylor, W. L. Waters, J. E. Woodbridge, and C. W. Stone.

General discussion of the advantages and disadvantages of the induction generator from the operating standpoint. Split-pole vs. alternating-current booster methods of e. m. f. regulation for converters.

VOLTAGE RATIO IN SYNCHRONOUS CONVERTERS WITH SPECIAL REFERENCE TO THE SPLIT-POLE CONVERTER

Comfort A. Adams — Vol. xxvii—1908, pp. 959-985

Determination of e. m. f. wave-form from the harmonic analysis of the flux distribution curve. The method is fully developed and then applied to two and three-part pole converters.

Discussion, incorporated with paper by J. L. Woodbridge on "Application of Storage Batteries to Regulation of Alternating-Current Systems."

INTERPOLES IN SYNCHRONOUS CONVERTERS

B. G. Lamme and F. D. Newbury **Vol. xxix—1910, pp. 1625-1653**

Analytical discussion of commutation in direct-current generators and synchronous converters, with reference to the advantages and disadvantages of commutating poles. General summary of the factors that limit the economical output of various types of converters.

Discussion, pp. 1654-1678, by Messrs. Gano Dunn, H. F. T. Erben, C. P. Steinmetz, Jens Bache-Wiig, P. M. Lincoln, J. L. Burnham, C. W. Stone, C. A. Adams, and B. G. Lamme.

General remarks on the use of commutating poles in synchronous converters, with special reference to interurban service where load factor is very low. Additional data on the design and limitating factors in synchronous converter construction.

10. STEAM BOILERS AND PRIME MOVERS

ANGULAR VARIATION IN STEAM ENGINES

P. O. Keilholtz — Vol. xviii—1901, pp. 703-740

Mathematical investigation of the turning moments due to steam and to inertia of the reciprocating parts, developing method of determining the relation between balancing effect of fly-wheel and the deviation from the position of absolutely uniform speed. Description of method of measuring any velocity variations by means of electrically driven tuning fork with detailed results of tests on a tandem compound engine.

Discussion, incorporated with that of paper by Walter I. Slichter on "Angular Velocity in Steam Engines in Relation to Paralleling of Alternators."

PARALLEL OPERATION OF ENGINE-DRIVEN ALTERNATORS

W. L. R. Emmet — Vol. xviii—1901, pp. 745-751

Account of the development of an anti-surging device for application to engine governors to enable parallel operation of alternators under all conditions of load.

Discussion, incorporated with that of paper by Walter I. Slichter on "Angular Velocity in Steam Engines in Relation to Paralleling of Alternators."

ANGULAR VELOCITY IN STEAM ENGINES IN RELATION TO PARALLELING OF ALTERNATORS

Walter I. Slichter — Vol. xviii—1901, pp. 759-771

Analytical discussion of causes and effects of irregular crank effort. Actual analysis of performance of engine of given design.

Discussion (included with that of paper by P. O. Keilholtz on "Angular Variations in Steam Engines," paper by Chas. P. Steinmetz on "Speed Regulation of Prime Movers and Parallel Operation of Alternators," paper by W. L. R. Emmett on "Parallel Operation of Engine Driven Alternators," and paper by Ernst J. Berg on "Parallel Running of Alternators"), pp. 772-800, by Messrs. R. H. Rice, Jas. A. Seymour, C. F. Scott, R. D. Mershon, W. L. R. Emmet, B. A. Behrend, and August H. Kruesi.

General remarks on requirements of parallel operation of alternators and cause and remedy for hunting. Relation between regulation characteristics of engine and division of load. Methods of measuring angular deviation.

ECONOMICAL AND SAFE LIMITS IN THE SIZE OF CENTRAL STATIONS

H. A. Lardner — Vol. xxi—1903, pp. 407-416

Brief discussion of the factors that bear upon the relative economy of one large and several small stations. Probable effect of steam turbines

on size of generator units. Actual figures as to most economical size of steam engine. Classified advantages and disadvantages of large central stations.

Discussion, incorporated with that of paper by Peter Junkersfeld on "Multiple Versus Independent Operation of Units and Central Stations."

GAS POWER FOR CENTRAL STATIONS

J. R. Bibbins Vol. xxii—1903, pp. 767-790

Analysis of the performance of a number of gas engine stations, covering the operation characteristics, the economy and cost of operation and maintenance. Discussion of the advantages of operating a gas-electric station in connection with gas works, with estimated revenues and cost of operation and maintenance. Much data in tabular form and in form of characteristic curves.

Discussion, pp. 791-797, by Messrs. Ralph D. Mershon, Philip Torchio, Herbert A. Wagner, H. G. Stott, and J. R. Bibbins.

Fixed charges of gas-electric and steam-electric plants. Amount of jacket water required by gas engines under different conditions. Relative importance of labor and maintenance with gas and steam engines.

NOTES ON FLY-WHEELS

H. H. Barnes, Jr. Vol. xxiii—1904, pp. 353-363

Analytical study of relation of fly-wheel effect to hunting, giving directions for predetermining the natural frequency of oscillation of a given system.

Discussion, pp. 461-466, by Messrs. H. H. Barnes, Jr., W. S. Franklin, Clarence P. Feldman, and H. Y. Hall, Jr.

General remarks on hunting of water-turbine, gas-engine and steam-engine driven machines.

POWER PLANT ECONOMICS

Henry G. Stott Vol. xxv—1906, pp. 1-27

Complete analysis of the losses involved in the transformation of heat energy from coal into electrical energy, the data being taken from one year's record in the power plant of the Interborough Rapid Transit Company. Characteristics and maintenance and operation charges for various prime movers—steam engines, steam turbines, steam engines and exhaust turbines, gas engines, gas engines and steam turbines. Methods of operation suggested whereby best plant economy could be improved.

Discussion, pp. 28-60, by Messrs. E. W. Rice, Jr., Chas. E. Lucke, C. C. Chappelle, W. L. R. Emmett, F. E. Junge, Calvert Townley, Hartley LeH. Smith, Paul M. Lincoln, W. E. Moore, Rudolph Wintzer, and J. R. Bibbins.

General discussion of the characteristics, economy and cost of operation of various prime movers, with special reference to low pressure turbines and gas engines. Notes on gas engine practice in Europe. Effect of load factor on cost of electric energy.

AUTOMATIC SAFETY DEVICES FOR STEAM ENGINES, TURBINES AND MOTORS

Chas. M. Heminway — Vol. xxv—1906, pp. 635-641

Types and applications of automatic engine stops, value of the protection and methods of maintenance of devices in proper condition.

No discussion.

GAS ENGINE REGULATION FOR DIRECT-CONNECTED UNITS

Charles E. Lucke — Vol. xxvi—1907, pp. 1-24

General discussion of speed regulation problems, defining the function of governors, fly-wheels and valve gears, and listing the variables that enter into the problem. The use of crank-pin force and speed diagrams, in the solution of such problems, is suggested and its application to steam turbine operation used as an illustration. A number of papers before the A. I. E. E. and A. S. M. E. on this subject are abstracted and commented upon.

No discussion.

THE RATIO OF HEATING SURFACE TO GRATE SURFACE AS A FACTOR IN POWER PLANT DESIGN

Walter S. Finlay, Jr. — Vol. xxvi—1907, pp. 1709-1719

Account of results obtained in the power plant of the Interborough Rapid Transit Company by installing a second grate under the existing boilers. Analytical study of the economy and saving produced thereby, with graphical performance diagrams and tabular comparison of the cost of maintenance and operation of the single and double grate plants.

Discussion, pp. 1720-1737, by Messrs. Charles E. Lucke, W. F. Wells, Walter T. Ray, Henry Keisinger, W. L. Abbott, A. Bement, F. V. Henshaw, W. S. Finlay, Albert A. Cary, J. P. Sparrow, and J. E. Moultrop.

General remarks on boiler efficiency, with results of experimental investigation and tests on methods of improving efficiency. Actual figures on grate surface, heating surface, rate of combustion, efficiency, etc.

AN EXHAUST STEAM TURBINE PLANT

Henry H. Wait — Vol. xxvi—1907, pp. 1739-1863

Results of tests on low-pressure turbines with different vacua and steam pressures at the plant of the Wisconsin Steel Company, Chicago.

Discussion, pp. 1764-1769, by Messrs. Francis Hodgkinson and J. R. Bibbins.

Characteristics and tests of low-pressure turbine performance.

DOUBLE-DECK STEAM TURBINE POWER PLANTS

J. R. Bibbins — Vol. xxvii—1908, pp. 1099-1118

General discussion of the advantages of the double-deck turbine station, based on a description of three actual plants, giving space, weights, foundation design, cost and other interesting features.

Discussion, pp. 1119-1121, by Messrs. C. W. Ricker and J. R. Bibbins.

Actual itemized cost of West Point double-deck turbine station.

WORKING RESULTS—GAS-ELECTRIC POWER PLANTS

J. R. Bibbins Vol. xxvii—1908, pp. 1123-1134

Account of thirty-day test of producer-gas engine plant, with analysis of results indicating the commercial efficiency and the cost of energy at different load-factors. Comparison of costs with steam-turbine station practice.

Discussion, pp. 1135-1137, by Messrs. J. P. Jackson and J. R. Bibbins. Reliability and overload capacity of gas engines.

FUEL—THE PURCHASE OF, ON A BRITISH THERMAL UNIT BASIS

Lawrence P. Crecelius Vol. xxviii—1909, pp. 51-62

Details of a fuel contract on heat unit basis and discussion of sampling and testing.

No discussion.

PRIME MOVERS

Charles P. Steinmetz Vol. xxviii—1909, pp. 63-84

Theoretical discussion of ideal economics of electrical energy production. Characteristics and limitations of various types of prime movers.

Discussion, pp. 85-99, by Messrs. Louis A. Ferguson, Charles E. Lucke, Henry E. Longwell, David B. Rushmore, Calvert Townley, and Ernst J. Berg.

Sharp criticisms of the paper. Factors to be considered in choosing prime movers. Numerical examples showing relative cost of energy production by water power and steam.

NOTES ON THE COST OF POWER

H. G. Stott Vol. xxviii—1909, pp. 1479-1502

Graphical charts showing results of calculations on the cost of energy as effected by load, load factor and load curve, with different types of prime movers—reciprocating engines, steam turbines, reciprocating engine and exhaust turbine, gas engine and steam turbine, and hydraulic turbines.

No discussion.

TESTS OF A 15,000-KW. STEAM-ENGINE-TURBINE UNIT

H. G. Stott and R. J. S. Pigott Vol. xxix—1910, pp. 183-229

Description of the combined high-pressure reciprocating engine and low-pressure turbo-induction generator plant of the Interborough Rapid Transit Company, together with reasons for adopting this type of apparatus and summary of results accomplished by its use. Results and principal data of tests covering economy and performance of the prime movers are presented in tabular and diagrammatic form.

Discussion, pp. 230-248, by Messrs. W. L. R. Emmet, Max Rotter, E. F. Miller, Edward L. Clark, E. D. Dreyfus, Charles P. Steinmetz, J. W. Lieb, Jr., D. S. Jacobus, ——— Schauber, G. R. Parker, O. Junggren, F. Samuelson, R. J. S. Pigott, and H. G. Stott.

THE GENERATING SYSTEM OF AN ELECTRIC LIGHTING COMPANY

A. R. Cheyney Vol. xxix—1910, pp. 339-360

General discussion of important economic features in the operation of large central station plants, showing how economy, efficiency and reliability are maintained in every state of the process from the coal mine to the outgoing feeders of the sub-station

No discussion.

GAS ENGINES IN CITY RAILWAY AND LIGHTING SERVICE

E. D. Latta, Jr. Vol. xxix—1910, pp. 429-461

Description of the gas engine plant of the Charlotte Electric Railway Company, followed by a detailed explanation of the mode of operation of the engines and the producers, together with actual performance record as to shut-downs, speed regulation, parallel running, cost of operation, maintenance and repairs. The theory of producer gas manufacture and combustion.

Discussion, pp. 462-464, by Messrs. H. K. English, F. D. Gatchell, and E. D. Latta, Jr.

Additional data on piston-rod packing and the slow oxidation of coal.

TESTING STEAM TURBINES AND STEAM TURBO-GENERATORS

E. D. Dickinson and L. T. Robinson Vol. xxix—1910, pp. 1679-1688

Brief description of methods of testing turbo-generator units, pointing out the precaution that must be exercised in order to attain a high degree of accuracy.

Discussion, pp. 1689-1707, by Messrs. Gano Dunn, W. L. R. Emmet, Francis Hodgkinson, W. L. Robb, Edwin D. Dreyfus, W. C. L. Eglin, A. Henry Pikler, E. W. Yearsley, E. B. Rosa, L. T. Robinson, I. E. Moultrop, and E. D. Dickinson.

General remarks on turbine and turbo-generator testing correction factors, methods of test, accuracy of different measurements, etc.

11. POWER PLANTS

A. BUILDINGS

CEMENT IN CENTRAL STATION DESIGN

Eugene B. Clark — Vol. xxiv—1905, pp. 55-63

Description of the construction and installation of concrete floors, roofs, switch cells, conduits, etc.

No discussion.

B. ECONOMICS

ECONOMICAL AND SAFE LIMITS IN THE SIZE OF CENTRAL STATIONS

H. A. Lardner — Vol. xxi—1903, pp. 407-416

Brief discussion of the factors that bear upon the relative economy of one large and several small stations. Probable effect of steam turbines on size of generator units. Actual figures as to most economical size of steam engine. Classified advantages and disadvantages of large central stations.

Discussion, incorporated with that of paper by Peter Junkersfeld on "Multiple Versus Independent Operation of Units and Central Stations."

CENTRAL STATION ECONOMIES

W. E. Goldsborough and P. E. Fansler — Vol. xxii—1903, pp. 467-499

Description of power plant of the Indiana Union Traction Company and methods used in testing the equipment. Detailed discussion of tests, giving losses in the different parts of the system and the efficiency of the different steps in the transmission from the coal pile to the cars.

Discussion, pp. 500-505, by Messrs. W. E. Goldsborough, M. H. Gerry, Jr., H. G. Stott, Gano S. Dunn, W. F. Wells, and P. M. Lincoln.

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DUPLICATION OF ELECTRICAL APPARATUS TO SECURE RELIABILITY OF SERVICE

H. W. Buck — Vol. xxiv—1905, pp. 261-268

Brief detailed discussion of the conditions which govern the economic usefulness of reserve apparatus in different divisions of a power plant system.

Discussion (including that of paper by George F. Chellis on "Time-Limit Relays"), pp. 269-282, by Messrs. H. G. Stott, Philip Torchio, C. O. Mailloux, S. D. Sprong, W. F. Wells, G. F. Chellis, H. W. Buck, H. R. Stuart, P. M. Lincoln, and Charles F. Scott.

General remarks on and experience with time-limit relays. Description of the relay practice of The New York Edison Company. Practice of large company in maintaining continuity of service.

POWER PLANT ECONOMICS

Henry G. Stott — Vol. xxv—1906, pp. 1-27

Complete analysis of the losses involved in the transformation of heat energy from coal into electrical energy, the data being taken from one year's record in the power plant of the Interborough Rapid Transit Company. Characteristics and maintenance and operation charges for various prime movers—steam engines, steam turbines, steam engines and exhaust turbines, gas engines and steam turbines. Methods of operation suggested whereby best plant economy could be improved.

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THE RELATION OF LOAD FACTOR TO THE EVALUATION OF HYDROELECTRIC PLANTS

S. B. Storer — Vol. xxv—1906, pp. 139-143

Brief theoretical study of effect of load factor on cost of electric energy production in steam and water power plants.

No discussion.

AN ANALYSIS OF THE DISTRIBUTION LOSSES IN A LARGE CENTRAL STATION SYSTEM

L. L. Elden — Vol. xxvi—1907, pp. 665-680

Record of four years' study of the losses in a certain large energy distribution system, with an account of methods employed to reduce losses between switchboard and consumer.

No discussion.

THE RATIO OF HEATING SURFACE TO GRATE SURFACE AS A FACTOR IN POWER PLANT DESIGN

Walter S. Finlay, Jr. **Vol. xxvi—1907, pp. 1709-1719**

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Sharp criticisms of the paper. Factors to be considered in choosing prime movers. Numerical examples showing relative cost of energy production by water power and steam.

CENTRALIZATION OF POWER SUPPLY

Presidential Address

Louis A. Ferguson **Vol. xxviii—1909, pp. 355-361**

Financial, technical and industrial advantages of centralization of electrical energy production.

No discussion.

COMMENTS ON THE OPERATION AND DEVELOPMENT OF HYDROELECTRIC PLANTS

Henry L. Doherty **Vol. xxviii—1909, pp. 1361-1379**

General discussion of certain features in the operation and development of hydroelectric plants with a view to improving the standing and value of water-power securities.

Discussion, pp. 1380-1478, by Messrs. L. B. Stillwell, Henry G. Stott, S. E. Doane, Cary T. Hutchinson, H. W. Buck, W. N. Ryerson, Calvert Townley, Julian C. Smith, Henry L. Doherty, Carl Schwartz, C. P. Fowler, J. Lester Woodbridge, W. E. Winship, Francis Blossom, Philip P. Barton, C. H. Baker, H. F. Parshall, J. F. Vaughan, E. C. Brown, J. H. Wilson, James Lyman, R. A. Ross, M. H. Collbohm, H. A. Storrs, E. P. Roberts, P. W. Sothman, O. S. Lyford, Jr., D. S. Jacobus, Ralph

D. Mershon, David B. Rushmore, John Martin, Irving E. Brooke, and W. G. Chace.

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No discussion.

THE APPLICABILITY OF ELECTRICAL POWER TO INDUSTRIAL ESTABLISHMENTS

Dugald C. Jackson **Vol. xxix—1910, pp. 107-114**

General outline of the advantages of electric power in manufacturing plants, touching upon the cost of producing energy in steam plants and pointing out the advantages of centralizing energy production of factories in same locality.

Discussion, incorporated with that of Mr. Walter B. Nye's paper on "The Requirements for an Induction Motor from the User's Point of View."

CENTRAL STATIONS VERSUS ISOLATED PLANTS FOR TEXTILE MILLS

Charles T. Main **Vol. xxix—1910, pp. 115-127**

Analytical discussion of the cost of energy for operating textile mills under various conditions, with special reference to advantages and disadvantages of central station service.

Discussion, incorporated with that of Mr. Walter B. Nye's paper on "The Requirements for an Induction Motor from the User's Point of View."

THE SUPPLY OF ELECTRICAL POWER FOR INDUSTRIAL ESTABLISHMENTS FROM CENTRAL STATIONS

R. S. Hale **Vol. xxix—1910, pp. 129-137**

General discussion of the relative cost of energy production in a central station and in isolated manufacturing plants, with special reference to items usually overlooked in making such estimates.

Discussion, incorporated with that of Mr. Walter B. Nye's paper on "The Requirements for an Induction Motor from the Users' Point of View."

THE GENERATING SYSTEM OF AN ELECTRIC LIGHTING COMPANY

A. R. Cheyney Vol. xxix—1910, pp. 339-360

General discussion of important economic features in the operation of large central station plants, showing how economy, efficiency and reliability are maintained in every state of the process from the coal mine to the outgoing feeders of the sub-station.

No discussion.

DIVERSITY FACTOR

H. B. Gear Vol. xxix—1910, pp. 375-384

Analytical discussion of diversity factor between various elements of the distribution system and of various classes of business, showing its effect on initial investment and cost of service.

No discussion.

C. HYDROELECTRIC PLANTS

THE ELECTRIC TRANSMISSION OF POWER FROM NIAGARA FALLS

Lewis B. Stillwell Vol. xviii—1901, pp. 445-531

Historical outline of the development, design, construction and operation of the electrical equipment of the Niagara Falls power plant. Description of the generators, their design and their performance under tests and in operation. Also a description of the transmission and distribution system, its construction and difficulties encountered in its operation.

Discussion, pp. 532-544, by Messrs. L. B. Stillwell, Chas. P. Steinmetz, H. W. Buck, P. M. Lincoln, E. A. Sperry, F. A. C. Perrine, P. K. Stern, H. G. Stott, and Clarence E. Gifford.

General discussion of the methods of operation for large transmission and distribution systems with reference to interruptions from various causes. Experience with grounded wire on long lines in the West. Difficulties in operation of railway converter sub-stations in Buffalo.

THE NEW GENERATING PLANTS OF THE NIAGARA FALLS POWER COMPANY

H. W. Buck Vol. xix—1902, pp. 765-780

Brief description of the No. 2 American power house and of the Canadian power house, giving general data concerning the equipment, the wiring and the switchboards.

Discussion, incorporated with that of paper by Chas. P. Steinmetz on "Notes on the Theory of the Synchronous Motor."

AN EFFICIENT HIGH-PRESSURE WATER-POWER TRANSMISSION PLANT

George J. Henry, Jr., and Joseph N. Le Conte Vol. xxii—1903, pp. 627-645

General description of Pelton wheels and hydraulic equipment for 1923-ft. head. Methods of making performance tests, the results of tests being given in tables and curves.

Discussion, pp. 646-647, by Messrs. F. O. Blackwell and H. A. Lardner.

First three-phase transmission plant in United States. Pipe lines for high pressure.

WATER POWERS OF THE SOUTH EASTERN APPALACHIAN REGION.

Frederick A. C. Perrine — Vol. xxiv—1905, pp. 789-800

Brief comparison of the general characteristics of the Appalachian system with other great mountain ranges of the United States. Short résumé of the different water sheds in the South Appalachian system, giving area, rainfall, run-off characteristics, etc.

Discussion, pp. 801-806, by Messrs. Ralph W. Pope, C. E. Waddell, L. S. Randolph, A. M. Schoen, F. A. C. Perrine, Carl Hering, J. W. Lieb, Jr., and Gano S. Dunn.

General remarks on hydroelectric power development. Relation between rainfall, distribution and uniformity of run-off. Motion carried to appoint a water power conservation committee.

THE DEVELOPMENT OF THE ONTARIO POWER COMPANY.

P. N. Nunn — Vol. xxiv—1905, pp. 807-833

Description of the layout and construction of the generating and distribution plants, profusely illustrated with photographs and working drawings.

Discussion, pp. 834-838, by Messrs. Gano S. Dunn, W. E. Goldsborough, H. G. Stott, P. H. Thomas, C. A. Greenidge, P. N. Nunn, and Philip P. Barton.

Probable effect of taking water at Chicago upon the flow at Niagara Falls. Characteristics of ice formation in the Niagara River and cause of ice difficulties experienced by Niagara Falls Power Company.

THE RELATION OF LOAD-FACTOR TO THE EVALUATION OF HYDROELECTRIC PLANTS

S. B. Storer — Vol. xxv—1906 pp. 139-143

Brief theoretical study of effect of load-factor on cost of electric energy production in steam and water-power plants.

No discussion.

NOTES ON DESIGN OF HYDROELECTRIC POWER STATIONS

David B. Rushmore — Vol. xxv—1906 pp. 145-163

General remarks on some of the factors which enter into the design of a hydroelectric plant. Determination of the magnitude of a given development, choice of wheel and generator rating, of speed, and of efficiency with respect to economy of operation. Data on hydraulic system taken from Reclamation Service.

No discussion.

A NEW METHOD OF TURBINE CONTROL

Lamar Lyndon — Vol. xxv—1906 pp. 165-177

Theory and description of a water wheel governor designed to compensate pressure rises in pipe systems and to prevent overrunning.

Discussion, pp. 178-179, by Messrs. Paul Spencer, Lamar Lyndon, and Carl Hering.

ELECTRIC POWER TRANSMISSION

Frederick Darlington

Vol. xxv—1906 pp. 181-190

General classification of natural water powers and loads which may be carried by such powers. Outline of data that must be determined in developing water power. Preliminary data and detailed estimates of cost of energy production in a certain plant in the Southern Appalachian mountains; also estimated cost of steam competition.

No discussion.

ECONOMIES TO BE DERIVED FROM THE UTILIZATION OF WATER POWERS OF LOW HEAD IN THE CENTRAL WEST

Dugald C. Jackson

Vol. xxv—1906, pp. 585-600

Description of development of three water powers by the Janesville Electric Company in Janesville, Wis.

No discussion.

NOTES ON HYDROELECTRIC PLANT ORGANIZATION AND OPERATION

Farley Osgood

Vol. xxvi—1907, pp. 179-199

Brief general outline of the points to be covered in the development and equipment of a hydroelectric plant, followed by a collection of actual experiences in the operation of a modern plant.

No discussion.

COMMENTS ON THE OPERATION AND DEVELOPMENT OF HYDROELECTRIC PLANTS

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EMERGENCY GENERATING STATIONS FOR SERVICE IN CONNECTION WITH HYDRO-ELECTRIC TRANSMISSION PLANTS UNDER PACIFIC COAST CONDITIONS

A. M. Hunt **Vol. xxix—1910, pp. 675-684**

Analytical study of the comparative merits of a gas engine and a steam turbine station for standby service, covering first costs, standby charges and continuous operation cost. The steam plant is kept in readiness to start by storing electrically generated heat in water under high pressure.

Discussion, pp. 685-704, by Messrs. L. B. Stillwell, L. Jorgensen, K. G. Dunn, C. L. Cory, L. L. Johnston, A. H. Babcock, W. A. Doble, F. G. Baum, A. M. Hunt, Cary T. Hutchinson, and P. H. Thomas.

General remarks on standby service in connection with hydroelectric plants, comparing conditions in the West with those in the East and considering the relative value of gas engine, steam and water-power so well built as to require no standby service.

HYDROELECTRIC POWER AS APPLIED TO IRRIGATION

John Coffee Hays **Vol. xxix -1910, pp. 731-753**

Description of a large ground water system of irrigation (Mount Whiting Power Company in California) operated with hydroelectric energy, covering the power equipment; forms of contracts and charges; load characteristics; power requirements for different classes of work, and effect of irrigation on land values.

Discussion, pp. 754-764, by Messrs. L. B. Stillwell, E. W. Paul, J. C. Hays, F. V. Henshaw, H. Homberger, L. Jorgensen, Ralph W. Pope, Markham Cheever, A. J. Bowie, Jr., W. A. Doble, and F. G. Baum.

General discussion of the relative advantages of construction having limited life and construction which is practically permanent, also general remarks on irrigation.

D. STEAM AND GAS-ELECTRIC PLANTS

TENDENCIES OF CENTRAL STATION DEVELOPMENT

Vol. xxi—1903, pp. 403-405

Introduction by President Chas. F. Scott.

ECONOMICAL AND SAFE LIMITS IN THE SIZE OF CENTRAL STATIONS

H. A. Lardner **Vol. xxi—1903 pp. 407-416**

Brief discussion of the factors that bear upon the relative economy of one large and several small stations. Probable effect of steam turbines on size of generator units. Actual figures as to most economical size of steam engine. Classified advantages and disadvantages of large central stations.

Discussion, incorporated with that of paper by Peter Junkersfeld on "Multiple Versus Independent Operation of Units and Central Stations."

MULTIPLE VERSUS INDEPENDENT OPERATION OF UNITS AND CENTRAL STATIONS

Peter Junkersfeld Vol. xxi—1903 pp. 425-440

General discussion of troubles encountered in the operation of a central station system, covering the different links between the coal pile and the consumer's circuits. Layout for sectional operation of large central station and advantages of this method of operation.

Discussion (including that of paper by H. A. Lardner on "Economical and Safe Limits in the Size of Central Stations," and paper by Philip Torchio on "Safety Devices in Central Stations and Sub-stations"), pp. 441-477, by Messrs. C. F. Scott, H. G. Stott, H. A. Wagner, F. A. Waldron, E. H. Sniffen, J. W. Lieb, Jr., Townsend Wolcott, W. S. Rugg, W. L. Abbott, P. Junkersfeld, H. A. Lardner, Philip Torchio, Philip K. Stern, B. J. Arnold, H. B. Gear, W. G. Carlton, Carl Schwartz, F. Hodgkinson, H. Etheridge, C. W. Rice, P. M. Lincoln, Franz Welz, W. C. L. Eglin, Horatio A. Foster, Carl Hering, Chas. Hewitt, and Paul Spencer.

General remarks on central station operation—Fuel handling, prime movers, distribution system, etc., bearing upon the relative merits of a single interconnected system and several independent systems. Economy tests of steam turbines and discussion of the advantages of this type of prime mover. Utility of storage batteries in the operation of continuous-current central station system.

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J. R. Bibbins Vol. xxii—1903 pp. 767-790

Analysis of the performance of a number of gas engine stations, covering the operation characteristics, the economy and cost of operation and maintenance. Discussion of the advantages of operating a gas-electric station in connection with gas works, with estimated revenues and cost of operation and maintenance. Much data in tabular form and in form of characteristic curves.

Discussion, pp. 791-797, by Messrs. Ralph D. Mershon, Philip Torchio, Herbert A. Wagner, H. G. Stott, and J. R. Bibbins.

Fixed charges of gas-electric and steam-electric plants. Amount of jacket water required by gas engines under different conditions. Relative importance of labor and maintenance with gas and steam engines.

MODERN CENTRAL STATION DESIGN AS EXEMPLIFIED BY THE NEW TURBO-GENERATOR STATION OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON

I. E. Moultrop — Vol. xxiv—1905 pp. 29-43

Description of principal features in the design of the power station with drawings of the station, wiring diagram and layout of switchboard.

Discussion, pp. 44-53, by Messrs. J. W. Lieb, Jr., H. G. Stott, F. C. Bates, Philip Torchio, J. H. Hallberg, C. O. Mailloux, W. F. White, I. E. Moultrop, and P. Junkersfeld.

Central station and financial statistics. Relative merits and costs of surface and barometric condensers. General remarks on central station design.

THE RATIO OF HEATING SURFACE TO GRATE SURFACE AS A FACTOR IN POWER PLANT DESIGN

Walter S. Finlay, Jr. — Vol. xxvi—1907 pp. 1709-1719

Account of results obtained in the power plant of the Interborough Rapid Transit Company by installing a second grate under the existing boilers. Analytical study of the economy and saving produced thereby, with graphical performance diagrams and tabular comparison of the cost of maintenance and operation of the single and double grate plants.

Discussion, pp. 1720-1737, by Messrs. Charles E. Lucke, W. F. Wells, Walter T. Ray, Henry Keisinger, W. L. Abbott, A. Bement, F. V. Henshaw, W. S. Finlay, Albert A. Cary, J. P. Sparrow, and J. E. Moultrop.

General remarks on boiler efficiency, with results of experimental investigation and tests on methods of improving efficiency. Actual figures on grate surface, heating surface, rate of combustion, efficiency, etc.

A NEW CO_2 RECORDER

C. O. Mailloux — Vol. xxvi—1907, pp. 1771-1787

Description of Orsat apparatus followed by detailed description of the Westover recorder.

Discussion, p. 1788, by A. A. Adler.

DOUBLE-DECK STEAM TURBINE POWER PLANTS

J. R. Bibbins — Vol. xxvii—1908, pp. 1099-1118

General discussion of the advantages of the double-deck turbine station, based on a description of three actual plants, giving space, weights, foundation design, cost and other interesting features.

Discussion, pp. 1119-1121, by Messrs. C. W. Ricker and J. R. Bibbins.

Actual itemized cost of West Point double-deck turbine station.

WORKING RESULTS, GAS-ELECTRIC POWER PLANTS

J. R. Bibbins — Vol. xxvii—1908, pp. 1123-1134

Account of thirty-day test of producer-gas engine plant, with analysis of results indicating the commercial efficiency and the cost of energy at

different load factors. Comparison of costs with steam-turbine station practice.

Discussion, pp. 1135-1137, by Messrs. J. P. Jackson and J. R. Bibbins. Reliability and overload capacity of gas engines.

THE PURCHASE OF FUEL ON A BRITISH THERMAL UNIT BASIS

Lawrence P. Crecelius

Vol. xxviii—1909, pp. 51-62

Details of a fuel contract on heat unit basis and discussion of sampling and testing.

No discussion.

TESTS OF A 15,000-KW. STEAM-ENGINE-TURBINE UNIT

H. G. Stott and R. J. S. Pigott

Vol. xxix—1910, pp. 183-229

Description of the combined high-pressure reciprocating engine and low-pressure turbo-induction generator plant of the Interborough Rapid Transit Company, together with reasons for adopting this type of apparatus and summary of results accomplished by its use. Results and principal data of tests covering economy and performance of the prime movers presented in tabular and diagrammatic form.

Discussion, pp. 230-248, by Messrs. W. L. R. Emmet, Max Rotter, E. F. Miller, Edward L. Clark, E. D. Dreyfus, Charles P. Steinmetz, J. W. Lieb, Jr., D. S. Jacobus, —— Schauber, G. R. Parker, O. Junggren, F. Samuelson, R. J. S. Pigott, and H. G. Stott.

E. ELECTRIC STATION APPARATUS AND WIRING

THE CONTROL OF HIGH-POTENTIAL SYSTEMS OF LARGE POWER

E. W. Rice, Jr.

Vol. xviii—1901, pp. 407-420

Description of the type H oil switches designed for Metropolitan Traction Company and Manhattan Railway Company plants, together with short account of performance of oil, air and expulsion tube type switches under tests at high tension. General discussion of principles which should govern the layout of a central station.

Discussion (including that of paper by William S. Aldrich and George W. Redfield on "Performance of an Artificial Forty-Mile Transmission Line;" paper by F. A. C. Perrine on "Elements of Design, Particularly Pertaining to Long Distance Transmission;" paper by Charles F. Scott on "The Induction Motor and the Rotary Converter, and Their Relation to the Transmission System," and paper by Chas. P. Steinmetz on "Theoretical Investigation of Some Oscillations of Extremely High Potential in Alternating-Current High-Potential Transmissions"), pp. 421-442 and 667-669, by Messrs. Gano S. Dunn, Geo. D. Shepardson, Henry W. Fisher, W. L. R. Emmett, A. E. Kennelly, Chas. P. Steinmetz, F. A. C. Perrine, L. B. Stillwell, Oberlin Smith, R. D. Mershon, Paul Janet, W. S. Aldrich, C. F. Scott, and Percy H. Thomas.

Relative advantages and comparative performance of induction motors and synchronous motors. Atmospheric losses at high-tension lines as affected by diameter and stranding of conductor. Equation of rise of potential due to opening a circuit.

OIL SWITCHES FOR HIGH PRESSURES

E. M. Hewlett Vol. xxiii—1904, pp. 215-216

Comparison of oil break with air break switches.

Discussion, pp. 217-224, 242-245 and 249-251, by Messrs. C. C. Chesney, F. A. C. Perrine, Alex Dow, Ralph D. Mershon, C. F. Scott, P. N. Nunn, C. L. de Muralt, H. F. Parshall, W. A. Blanck, James Lyman, P. Junkersfeld, W. G. Carlton, E. O. Sessions, G. N. Eastman, I. E. Brooke, P. H. Thomas, R. F. Schuchardt, Edw. Schildhauer, H. F. Sanville, W. C. L. Eglin.

Experience with oil switches in many large plants. Accounts of tests under short circuit conditions. Specifications for oil switches and brief reference to some of the mechanical difficulties encountered with present types.

DUPLICATION OF ELECTRICAL APPARATUS TO SECURE RELIABILITY OF SERVICE

H. W. Buck Vol. xxiv—1905, pp. 261-268

Brief detailed discussion of the conditions which govern the economic usefulness of reserve apparatus in different divisions of a power plant system.

Discussion (including that of paper by George F. Chellis on "Time-Limit Relays"), pp. 269-282, by Messrs. H. G. Stott, Philip Torchio, C. O. Mailloux, S. D. Sprong, W. F. Wells, G. F. Chellis, H. W. Buck, H. R. Stuart, P. M. Lincoln, and Charles F. Scott.

General remarks on and experience with time-limit relays. Description of the relay practice of The New York Edison Company. Practice of large company in maintaining continuity of service.

ELECTRICAL CONNECTIONS FOR POWER STATIONS

David B. Rushmore Vol. xxv—1906, pp. 559-584

General discussion of the choice and arrangement of station apparatus. Classification of switches, relays and modes of connecting generator and station equipment to the lines.

No discussion.

ENCLOSED STATION WIRING

F. O. Blackwell Vol. xxvi—1907, 851-856

Photographs of high-potential arcs. General rules for wiring high-tension stations.

Discussion, pp. 857-871, by Messrs. C. W. Stone, L. C. Marburg, P. M. Lincoln, E. N. Lake, J. D. Jamieson, Fay Woodmansee, P. B. Woodworth,

W. B. Jackson, Dugald C. Jackson, Edwin W. Olds, Bertrand P. Rowe, Stephen Q. Hayes, C. W. Hutton; William McClellan, and L. A. Herdt.

General discussion of the interior high-tension wiring, with special reference to the advisability of enclosing the conductors in fireproof compartments.

SWITCHBOARD PRACTICE FOR VOLTAGES OF 60,000 AND UPWARDS

Stephen Q. Hayes — Vol. xxvi—1907, pp. 1333-1357

Brief general discussion of factors which enter into the choice and arrangement of control apparatus in high-tension plants, with special reference to oil switches and circuit breakers. Designs for 60,000 and 100,000-volt stations given to demonstrate the relative space required.

Discussion, pp. 1358-1362, by Messrs. P. M. Lincoln, F. B. H. Paine, D. B. Rushmore, H. W. Buck, J. B. Taylor, William McClellan, W. N. Smith, L. C. Nicholson, S. Q. Hayes, J. H. Finney, F. G. Baum, and Ralph D. Mershon.

Use of extra line wire for emergency service. Method of tying conductors to pin type insulators.

THE NON-SYNCHRONOUS GENERATOR IN CENTRAL STATION AND OTHER WORK

W. L. Waters — Vol. xxvii—1908, pp. 157-180

General characteristics of induction generator; method of operation; methods of excitation; regulation; behavior on short circuits; advantages in connection with steam turbine and gas engine drive.

Analytical discussion of its suitability to different kinds of service—large and small central stations and in the production of direct-current with steam turbines.

Discussion, incorporated in paper by J. E. Woodbridge on "Some Features of Railway Converter Design and Operation."

PARALLEL OPERATION OF HYDROELECTRIC PLANTS

W. S. Lee — Vol. xxix—1910, pp. 547-557

General discussion of some of the economic advantages of operating hydroelectric plants in parallel, with all plants tied into one large high-tension distribution system, based on experience with plants of the Southern Power Company located on the southern slopes of the Appalachian Mountains.

Discussion, pp. 558-571, by Messrs. W. S. Lee, Charles E. Waddell, Percy H. Thomas, David B. Rushmore, A. M. Schoen, Carl Hering, H. N. Muller, W. L. Waters, Charles F. Scott, and Edward W. Shedd.

General discussion of the parallel operation of hydro-electric plants, with special reference to the use of induction generators and the regulation of speed and e. m. f.

PARALLEL OPERATION OF THREE-PHASE GENERATORS, WITH THEIR NEUTRALS INTERCONNECTED

George I. Rhodes Vol. xxix—1910, pp. 765-790

Analytical development of the relations between the factors that produce neutral currents in star-connected generators with interconnected neutrals, so as to permit a close predetermination of the magnitude of the currents, followed by an application of the equation to existing generators, the results being checked by tests. Remedies for the prevention of these currents are suggested.

Discussion, pp. 791-807, by Messrs. H. J. Ryan, S. J. Lisberger, G. I. Rhodes, C. L. Cory, L. B. Stillwell, C. F. Adams, Paul Downing, E. F. Scattergood, W. F. Lamme, P. M. Lincoln, C. A. Adams, S. B. Charters, Jr., W. A. Hillebrand, Ralph D. Mershon, and H. Y. Hall.

Some experience with plants operating with star-connected generators with interconnected neutrals. Laboratory reproduction of these conditions. Feasibility of applying author's remedies.

THE MODERN OIL SWITCH WITH SPECIAL REFERENCE TO SYSTEMS OF MODERATE VOLTAGE AND LARGE AMPERE CAPACITY

A. R. Cheyney Vol. xxix—1910, pp. 1091-1108

Analytical discussion of the present status of oil switch construction, pointing out lines along which future progress is apt to take place. Record of performance of 90 oil switches in actual service.

Discussion, pp. 1109-1124, by Messrs. Peter Junkersfeld, Ford W. Harris, C. W. Stone, D. B. Rushmore, C. P. Steinmetz, W. I. Donshea, V. Karapetoff, G. F. Sever, A. R. Cheyney, and E. M. Hewlett.

General remarks on design and operation of oil switches. Experience in operation and results of experimental study.

INTERPOLES IN SYNCHRONOUS CONVERTERS

B. G. Lamme and F. D. Newbury Vol. xxix—1910, pp. 1625-1653

Analytical discussion of commutation in direct-current generators and synchronous converters, with reference to the advantages and disadvantages of commutating poles. General summary of the factors that limit the economical output of various types of converters.

Discussion, pp. 1654-1678, by Messrs. Gano Dunn, H. F. T. Erben, C. P. Steinmetz, Jens Bache-Wiig, P. M. Lincoln, J. L. Burnham, C. W. Stone, C. A. Adams, and B. G. Lamme.

General remarks on the use of commutating poles in synchronous converters, with special reference to interurban service where load factor is very low. Additional data on the design and limitating factors in synchronous converter construction.

12. PARALLEL OPERATION

ANGULAR VARIATION IN STEAM ENGINES

P. O. Keilholtz Vol. xviii—1901, pp. 703-740

Mathematical investigation of the turning moments due to steam and to inertia of the reciprocating parts, developing method of determining the relation between balancing effect of fly-wheel and the deviation from the position of absolutely uniform speed. Description of method of measuring any velocity variations by means of electrically driven tuning fork with detailed results of tests on a tandem compound engine.

Discussion, incorporated with that of paper by Walter I. Slichter on "Angular Velocity in Steam Engines in Relation to Paralleling of Alternators."

SPEED REGULATION OF PRIME MOVERS AND PARALLEL OPERATION OF ALTERNATORS

Charles P. Steinmetz Vol. xviii—1901, pp. 741-744

Brief consideration of the features of speed regulation that affect parallel operation of alternators.

Discussion, incorporated with that of paper by W. I. Slitchter on "Angular Velocity in Steam Engine in Relation to Paralleling of Alternators."

PARALLEL OPERATION OF ENGINE-DRIVEN ALTERNATORS

W. L. R. Emmet Vol. xviii—1901, pp. 745-751

Account of the development of an anti-surging device for application to engine governors to enable parallel operation of alternators under all conditions of load.

Discussion, incorporated with that of paper by W. I. Slichter on "Angular Velocity in Steam Engine in Relation to Paralleling of Alternators."

PARALLEL RUNNING OF ALTERNATORS

Ernst J. Berg Vol. xviii—1901, pp. 753-757

Development of equation covering the principles of parallel operation of alternators, showing the effect of armature reaction, the cause of hunting and remedy.

Discussion, incorporated with that of paper by W. I. Slichter on "Angular Velocity in Steam Engine in Relation to Paralleling of Alternators."

ANGULAR VELOCITY IN STEAM ENGINES IN RELATION TO PARALLELING OF ALTERNATORS

Walter I. Slichter Vol. xviii—1901, pp. 759-771

Analytical discussion of causes and effects of irregular crank effort. Actual analysis of performance of engine of given design.

Discussion (included with that of paper by P. O. Keilholtz on "Angular Variations in Steam Engines," paper by Chas. P. Steinmetz on "Speed

Regulation of Prime Movers and Parallel Operation of Alternators," paper by W. L. R. Emmett on "Parallel Operation of Engine Driven Alternators," and paper by Ernst J. Berg on "Parallel Running of Alternators"), pp. 772-800, by Messrs. R. H. Rice, Jas. A. Seymour, C. F. Scott, R. D. Mershon, W. L. R. Emmet, B. A. Behrend, and August H. Kruesi.

General remarks on requirements of parallel operation of alternators and cause and remedy for hunting. Relation between regulation characteristics of engine and division of load. Methods of measuring angular deviation.

OPERATION OF SYNCHRONOUS CONVERTERS

S. C. Lindsay — Vol. xxiii—1904, pp. 345-351

Account of experience with the parallel operation of 60-cycle synchronous converter, where much trouble was experienced from hunting.

No discussion.

NOTES ON FLY-WHEELS

H. H. Barnes, Jr. — Vol. xxiii—1904, pp. 353-363

Analytical study of relation of fly-wheel effect to hunting, giving directions for predetermining the natural frequency of oscillation of a given system.

Discussion, pp. 461-466, by Messrs. H. H. Barnes, Jr., W. S. Franklin, Clarence P. Feldman, and H. Y. Hall, Jr.

General remarks on hunting of water turbine, gas engine and steam engine driven machines.

CONDITIONS FOR CONTINUOUS SERVICE OVER LINES OPERATED IN PARALLEL

M. H. Gerry, Jr. — Vol. xxiii—1904, pp. 547-550

Brief description of method of operating two transmission lines in parallel. Wiring diagram.

Discussion, p. 551, by Messrs. Ralph D. Mershon and P. H. Thomas.

SOME FEATURES AFFECTING THE PARALLEL OPERATION OF SYNCHRONOUS MOTOR-GENERATOR SETS

J. B. Taylor — Vol. xxv—1906, pp. 113-136

Analysis of phenomena causing unequal division of load between synchronous motor-generator sets, with requirements in design, construction and operation necessary to overcome these difficulties. Tests showing magnitude and character of unbalanced condition. Detailed directions for starting synchronous motor-generator sets.

Discussion, pp. 137-138, by Messrs. W. L. Waters and J. B. Taylor.

Experience in parallel operation of synchronous motor-generator sets.

INTERACTION OF SYNCHRONOUS MACHINES

Morgan Brooks Vol. xxvi—1907, pp. 1027-1046

Development of a circle diagram for representing the physical relations and quantities of ideal synchronous machines in parallel operation. Mathematical analysis of the problem and expressions for the input, output, losses, efficiency and synchronizing power.

Discussion, pp. 1047-1048, by Messrs. E. J. Berg, Charles P. Steinmetz, and Comfort A. Adams.

Practical limitations of Professor Brook's method. Origin of the circle diagram used in the paper.

PARALLEL OPERATION OF HYDROELECTRIC PLANTS

W. S. Lee Vol. xxix—1910, pp. 547-557

General discussion of some of the economic advantages of operating hydroelectric plants in parallel, with all plants tied into one large high-tension distribution system, based on experience with plants of the Southern Power Company located on the southern slopes of the Appalachian Mountains.

Discussion, pp. 558-571, by Messrs. W. S. Lee, Charles E. Waddell, Percy H. Thomas, David B. Rushmore, A. M. Schoen, Carl Hering, H. N. Muller, W. L. Waters, Charles F. Scott, and Edward W. Shedd.

General discussion of the parallel operation of hydroelectric plants, with special reference to the use of induction generators and the regulation of speed and e. m. f.

PARALLEL OPERATION OF THREE-PHASE GENERATORS, WITH THEIR NEUTRALS INTERCONNECTED

George I. Rhodes Vol. xxix—1910, pp. 765-790

Analytical development of the relations between the factors that produce neutral currents in star-connected generators with interconnected neutrals, so as to permit a close predetermination of the magnitude of the currents, followed by an application of the equation to existing generators, the results being checked by tests. Remedies for the prevention of these currents are suggested.

Discussion, pp. 791-807, by Messrs. H. J. Ryan, S. J. Lisberger, G. I. Rhodes, C. L. Cory, L. B. Stillwell, C. F. Adams, Paul Downing, E. F. Scattergood, W. F. Lamme, P. M. Lincoln, C. A. Adams, S. B. Charters, Jr., W. A. Hillebrand, Ralph D. Mershon, and H. Y. Hall.

Some experience with plants operating with star-connected generators with interconnected neutrals. Laboratory reproduction of these conditions. Feasibility of applying author's remedies.

13. TRANSMISSION LINES

A. STRUCTURAL FEATURES

THE ELECTRIC TRANSMISSION OF POWER FROM NIAGARA FALLS

Lewis B. Stillwell — Vol. xviii—1901, pp. 445-531

Historical outline of the development, design, construction and operation of the electrical equipment of the Niagara Falls power plant. Description of the generators, their design and their performance under tests and in operation. Also a description of the transmission and distribution system, its construction and difficulties encountered in its operation.

Discussion, pp. 532-544, by Messrs. L. B. Stillwell, Chas. P. Steinmetz, H. W. Buck, P. M. Lincoln, E. A. Sperry, F. A. C. Perrine, P. K. Stern, H. G. Stott, and Clarence E. Gifford.

General discussion of the methods of operation for large transmission and distribution systems with reference to interruptions from various causes. Experience with grounded wire on long lines in the West. Difficulties in operation of railway converter sub-stations in Buffalo.

THE BUFFALO HIGH-TENSION CABLE DISTRIBUTION SYSTEM

Harold W. Buck — Vol. xviii—1901, pp. 835-841

General description of system of distribution of Niagara power in Buffalo.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

MECHANICAL SPECIFICATIONS OF THE PROPOSED STANDARD INSULATOR PIN

Ralph D. Mershon — Vol. xxi-1903, pp. 233-237

Mathematical investigation of fiber stresses in wooden insulator pins with design and dimensions recommended for standard practice.

Discussion, incorporated with that of paper by W. S. Franklin on "Model Showing Distribution of Electromotive Force and Current Along a Single-Phase Alternating-Current Transmission Line."

THE TESTING OF INSULATORS

F. O. Blackwell — Vol. xxi—1903, pp. 239-243

Factors which enter into the selection and testing of line insulators, based upon actual experience in the operation of high-tension lines.

Discussion, incorporated with that of paper by W. S. Franklin on "Model Showing Distribution of Electromotive Force and Current Along a Single-Phase Alternating-Current Transmission Line."

BURNING OF WOODEN PINS ON HIGH TENSION TRANSMISSION LINES

C. C. Chesney

Vol. xxi—1903, pp. 253-260

Brief report of experience with charring of wooden pins in California, with photographs of the damaged pins.

Discussion, incorporated with that of paper by W. S. Franklin on "Model Showing Distribution of Electromotive Force and Current Along a Single-Phase Alternating-Current Transmission Line."

METHODS OF BRINGING HIGH-TENSION CONDUCTORS INTO BUILDINGS

C. E. Skinner

Vol. xxii—1903, pp. 313-318

Conditions that determine the choice of construction for line entries, and requirements that must be met by such constructions. Examples of medium and high-tension entries.

Discussion, pp. 319-329, by Messrs. Henry Floy, O. H. Ensign, A. L. Mudge, F. C. Pierce, J. Harisberger, R. F. Hayward, V. G. Converse, P. H. Thomas, P. M. Lincoln, and Louis Bell.

Description and sectional drawings of various types of high-tension entries in actual use.

AN EFFICIENT HIGH-PRESSURE WATER-POWER TRANSMISSION PLANT

George J. Henry, Jr. and Joseph N. LeConte

Vol. xxii—1903, pp. 627-645

General description of Pelton wheels and hydraulic equipment for 1,923-foot head. Methods of making performance tests, the results of tests being given in tables and curves.

Discussion, pp. 646-647, by Messrs. F. O. Blackwell and H. A. Lardner.

First three-phase transmission plant in United States. Pipe lines for high pressure.

OVERHEAD HIGH-TENSION DISTRIBUTING SYSTEMS IN SUBURBAN DISTRICTS

George H. Lukes

Vol. xxii—1903, pp. 735-739

General discussion of the construction and operation of a satisfactory distribution system for suburban towns and villages surrounding a large city.

Discussion, incorporated with that of paper by W. C. L. Eglin on "Safeguards and Regulations in Operation of Overhead Distributing Systems."

SAFEGUARDS AND REGULATIONS IN OPERATION OF DISTRIBUTING SYSTEMS

W. C. L. Eglin

Vol. xxii—1903, pp. 747-754

General specifications for the material and construction of overhead distribution systems so as to attain a high degree of safety in operation. Method of testing pole transformers that are damaged by lightning disturbances.

Discussion (including that of paper by George H. Lukes on "Overhead High-Tension Distributing Systems in Suburban Districts," and paper by

E. J. Bechtel on "Automatic Apparatus for Regulating Generator and Feeder Potentials"), pp. 755-765, by Messrs. H. B. Gear, G. T. Hanchett, Ralph D. Mershon, Calvert Townley, P. M. Lincoln, M. P. Ryder, George F. Sever, H. G. Stott, W. C. L. Eglin, A. C. Pratt, C. F. Scott, S. P. Grace, and C. H. Chalmers.

Analysis of accidents which interrupt service of overhead distribution systems and general rules for minimizing them. Construction of lines through trees. Rules for the protection of telephone lines from power lines.

EUROPEAN PRACTICE IN THE CONSTRUCTION AND OPERATION OF HIGH-PRESSURE TRANSMISSION LINES AND INSULATORS

Guido Semenza — Vol. xxiii—1904, pp. 147-163

Outline of method of designing transmission lines, selecting conductor section, line material and type of construction so as to attain proper balance between fixed and operating charges. Notes on relative merits of iron and wooden poles with comparative costs. Factors which enter into the design of insulators.

Discussion, pp. 164-168, by Messrs. W. N. Smith, B. J. Arnold, L. L. Perry, W. S. Dix, J. W. Lieb, Jr., C. F. Scott, N. J. Neall, and W. A. Blanck.

Relative merits of steel and wooden pole line construction.

LONG SPANS FOR TRANSMISSION LINES

F. O. Blackwell — Vol. xxiii—1904, pp. 511-521

Mechanical features in the design of long-span steel tower lines, giving the physical properties of copper, aluminum, iron and steel cable; sag span curves and equations, and tower construction.

Discussion, pp. 523-545, by Messrs. Ralph D. Mershon, F. O. Blackwell, A. S. Hatch, Charles F. Scott, N. J. Neall, William Hoopes, Eugene Clark, W. D. Ball, F. A. C. Perrine, W. B. Jackson, H. B. Alverson, Peter Junkersfeld, B. J. Arnold, H. C. Wirt, S. B. Storer, and R. F. Hayward.

General discussion of the relative merits and costs of metal poles and towers vs. wooden poles. Actual and estimated costs of different kinds of line construction.

ANSWERS TO QUESTIONS RELATIVE TO HIGH-TENSION TRANSMISSION

Vol. xxiii—1904, pp. 571-604

Report of High-Tension Committee giving questions and answers representing the actual standard practice in high-tension transmission line construction and operation.

Discussion, pp. 605-614, by Messrs. J. H. Finney, Ralph D. Mershon, Peter Junkersfeld, B. J. Arnold, L. Schuler, S. B. Storer, F. A. C. Perrine, Eugene Clark, W. B. Jackson, N. J. Neall, James Lyman, W. G. Carlton,

Charles F. Scott, G. N. Eastman, H. B. Alverson, F. Woodmansee, and G. R. Radley.

Protection of high-tension crossings by nets, grounded rings, etc. Percentage of total investment represented by transmission circuits. Comparative disturbance produced by opening high-tension air-break and oil-break switches. Experience with static discharges.

THE DEVELOPMENT OF THE ONTARIO POWER COMPANY

P. N. Nunn Vol. xxiv—1905, pp. 807-833

Description of the layout and construction of the generating and distribution plants, profusely illustrated with photographs and working drawings.

Discussion, pp. 834-838, by Messrs. Gano S. Dunn, W. E. Goldsborough, H. G. Stott, P. H. Thomas, C. A. Greenidge, P. N. Nunn, and Philip P. Barton.

Probable effect of taking water at Chicago upon the flow at Niagara Falls. Characteristics of ice formation in the Niagara River and cause of ice difficulties experienced by Niagara Falls Power Company.

HIGH-TENSION OUTLETS

Alvin Meyers Vol. xxv—1906, pp. 865-880

Experience with home-made outlet bushings on the Telluride Power Company's system. Complete specifications for construction and installation of 44,000-volt bushings, together with cost of material and labor.

No discussion.

TRANSMISSION LINE TOWERS AND ECONOMICAL SPANS

D. R. Scholes Vol. xxvi—1907, pp. 1221-1237

Derivation of mathematical expression for the weight of steel towers in terms of the stresses and establishment of relation between cost and width of base. Application of equations to determination of most economical span under given conditions.

Discussion, incorporated with paper by Norman Rowe on "Lightning-Rods and Grounded Cables as a Means of Protecting Transmission Lines Against Lightning."

A NEW TYPE OF INSULATOR FOR HIGH-TENSION TRANSMISSION LINES

E. M. Hewlett Vol. xxvi—1907, pp. 1259-1262

Illustrated description of the Hewlett link insulator.

Discussion, incorporated with paper by H. W. Buck on "Some New Methods in High-Tension Line Construction."

SOME NEW METHODS IN HIGH-TENSION LINE CONSTRUCTION

H. W. Buck — Vol. xxvi—1907, pp. 1263-1269

Brief description of transmission line construction with link type insulators, followed by list of advantages.

Discussion (including that of paper by E. M. Hewlett on "A New Type of Insulator for High-Tension Transmission Lines"), pp. 1270-1271, by Messrs. J. B. Whitehead, Ralph D. Mershon, Ralph W. Pope, F. B. H. Paine, and Charles P. Steinmetz.

Brief remarks on potential distribution between successive disks.

THE TRANSMISSION PLANT OF THE NIAGARA, LOCKPORT AND ONTARIO POWER COMPANY

Ralph D. Mershon — Vol. xxvi—1907, pp. 1273-1313

Description of the line construction and sub-station equipment. Profusely illustrated.

Discussion, pp. 1314-1317, by Messrs. E. J. Berg, Ralph D. Mershon, J. W. Fraser, and F. B. H. Paine.

Relative merits of metallic and concrete tower footings, with test results as to the holding-down power of the former.

LOCATION OF BROKEN INSULATORS AND OTHER TRANSMISSION LINE TROUBLES

L. C. Nicholson — Vol. xxvi—1907, pp. 1319-1329

Description of method of test and derivation of formulas of calculating distance to fault.

Discussion, pp. 1330-1331, by Messrs. L. T. Robinson, Ralph D. Mershon, and F. B. H. Paine.

Further elaboration of the method to increase its accuracy.

SOME POWER TRANSMISSION ECONOMICS

Frank G. Baum — Vol. xxvi—1907, pp. 1555-1569

Description of 60,000-volt transmission line construction used by California Gas and Electric Corporation. Designs for pole tops for spans of from 500 to 3,000 feet; home-made oil switches; outdoor switches, etc.

Discussion, pp. 1570-1572, by Messrs. Charles P. Steinmetz and F. B. H. Paine.

Difference between transmission line practice in the West and the East.

FUNDAMENTAL CONSIDERATIONS GOVERNING THE DESIGN OF TRANSMISSION-LINE STRUCTURES

D. R. Scholes — Vol. xxvii—1908, pp. 931-938

Brief discussion of the mechanical forces that enter into the design of transmission towers—wind pressure, sleet, breakage of lines and mechanical resistance of footings.

Discussion, pp. 939-944, by Messrs. N. J. Neall and Ralph Bennett.

General remarks on factors of safety and design of footings. Description of a method of testing towers. Data from the Kern River transmission system.

THE TESTING OF HIGH VOLTAGE LINE INSULATORS

C. E. Skinner — Vol. xxvii–1908, pp. 945-951

Proposed specifications for routine and design testing of high-tension line insulators.

Discussion, pp. 952-958, by Messrs. Percy H. Thomas, Ralph D. Mershon, Clayton H. Sharp, E. M. Hewlett, Chas. P. Steinmetz, C. E. Skinner, and N. J. Neall.

General remarks on insulator test specifications, with special reference to methods of making the rain test.

THE DEVELOPED HIGH TENSION NET-WORK OF A GENERAL POWER SYSTEM

Paul M. Downing — Vol. xxix–1910, pp. 705-719

Brief description of the Pacific Gas & Electric Company's system, with reference to the method of operation through a load dispatcher and also as to practice regarding connection, care and operation of transformers; construction of large capacity high-tension oil switches; lightning arresters and line insulators.

Discussion, pp. 720-729, by Messrs. Markham Cheever, L. B. Stillwell, L. R. Jorgensen, E. F. Scattergood, W. F. Wells, John Harisberger, P. M. Downing, A. M. Hunt, A. O. Austin, and C. F. Adams.

General remarks on the operation of very large high-tension distribution systems, with special reference to the automatic disconnection of disabled lines; the operation of telephone lines paralleling power lines, and the design of large capacity oil switches.

TRANSMISSION LINE CROSSINGS OF RAILROAD RIGHTS-OF-WAY

Allen H. Babcock — Vol. xxix–1910, pp. 905-909

A brief statement of the problem of transmission line crossing over railways, followed by general specifications for the construction of line crossing over the tracks of the Southern Pacific Railroad.

Discussion, pp. 910-926, by Messrs. John Harisberger, A. H. Babcock, A. M. Hunt, C. F. Adams, Lewis B. Stillwell, P. M. Downing, Markham Cheever, Sidney Sprout, J. P. Jollyman, R. W. Van Norden, Ralph D. Mershon, Frank F. Fowle, and Percy H. Thomas.

Criticisms and remarks on the Southern Pacific's suggested specifications.

B. ELECTRICAL FEATURES

THE DISTRIBUTION AND CONVERSION OF RECEIVED CURRENTS

Henry Gordon Stott — Vol. xviii–1901, pp. 125-152

Brief description of the transmission plant for generation, transformation and transmission of electric energy from Niagara Falls to Buffalo. Discussion of operative features: means adopted for the protection of the system; relative merits of synchronous converters and motor-generators; relative merits of various arc lighting systems; difficulties in synchronizing 60-cycle synchronous motors.

Discussion, pp. 153-163, by Messrs. Gano S. Dunn, Calvin W. Rice, H. G. Stott, C. P. Steinmetz, Elias E. Ries, Jos. Sachs, Jno. W. Lieb, Jr., and H. D. Reed.

Characteristics of three-phase induction motors for railway service. Relative performance of air-break and oil-break switches. Experiences with rubber insulated high-voltage cables.

PERFORMANCE OF AN ARTIFICIAL FORTY-MILE TRANSMISSION LINE

William S. Aldrich and George W. Redfield — **Vol. xviii—1901, pp. 339-360**

Description of apparatus used to duplicate a long line and account of performance tests under various conditions. Relation between line charging current and resonant rise. Line performance curves for loads of different power-factors—synchronous motors with under, normal and over excitation and with excitation varied to give constant receiver e. m. f. Wave form observed under various load conditions.

Discussion, incorporated with that of paper by E. W. Rice, Jr., on "The Control of High-Voltage Systems of Large Power."

ELEMENTS OF DESIGN PARTICULARLY PERTAINING TO LONG-DISTANCE TRANSMISSION

F. A. C. Perrine — **Vol. xviii—1901, pp. 361-369**

Discussion of effects of line capacity and inductance on regulation, with statement of conditions requisite for best regulation. Qualities of high-tension (50,000 to 60,000 volts) line insulation and the importance of continuity of service.

Discussion, incorporated with that of paper by E. W. Rice, Jr., on "The Control of High-Voltage Systems of Large Power."

THEORETICAL INVESTIGATION OF SOME OSCILLATIONS OF EXTREMELY HIGH POTENTIAL IN ALTERNATING HIGH POTENTIAL TRANSMISSIONS

Charles Proteus Steinmetz — **Vol. xviii—1901, pp. 383-405**

Mathematical investigation of the effect of the exponential term in the general equation for alternating-current circuits, followed by numerical examples showing the nature of disturbances due to opening a short circuit on the line and to connecting the line to a source of alternating current energy.

Discussion, incorporated with that of paper by E. W. Rice, Jr., on "The Control of High-Voltage Systems of Large Power."

THE ELECTRIC TRANSMISSION OF POWER FROM NIAGARA FALLS

Lewis B. Stillwell — **Vol. xviii—1901, pp. 445-531**

Historical outline of the development, design, construction and operation of the electrical equipment of the Niagara Falls power plant. Description of the generators, their design and their performance under tests and in operation. Also a description of the transmission and distribution system, its construction and difficulties encountered in its operation.

Discussion, pp. 532-544, by Messrs. L. B. Stillwell, Chas. P. Steinmetz, H. W. Buck, P. M. Lincoln, E. A. Sperry, F. A. C. Perrine, P. K. Stern, H. G. Stott, and Clarence E. Gifford.

General discussion of the methods of operation for large transmission and distribution systems with reference to interruptions from various causes. Experience with grounded wire on long lines in the West. Difficulties in operation of railway converter sub-stations in Buffalo.

FORMULA FOR CALCULATING THE ELECTROMOTIVE FORCE AT ANY POINT OF A TRANSMISSION LINE FOR ALTERNATING CURRENT

M. LeBlanc

Vol. xix—1902, pp. 759-763

Discussion, incorporated with that of paper by Chas. P. Steinmetz on "Notes on the Theory of the Synchronous Motor."

HIGH-TENSION TRANSMISSION LINES

Vol. xxi—1903, pp. 229-231

Introduction by President Chas. F. Scott.

THE TESTING OF INSULATORS

F. O. Blackwell

Vol. xxi—1903, pp. 239-243

Factors which enter into the selection and testing of line insulators, based upon actual experience in the operation of high-tension lines.

Discussion, incorporated with that of paper by W. S. Franklin on "Model Showing Distribution of Electromotive Force and Current Along a Single-phase Alternating-Current Transmission Line."

TRANSPOSITION AND RELATIVE LOCATION OF POWER AND TELEPHONE WIRES

P. M. Lincoln

Vol. xxi—1903, pp. 245-251

Outline of electromagnetic and electrostatic disturbances in telephone lines paralleling high-tension lines, with general directions for minimizing such disturbances.

Discussion, incorporated with that of paper by W. S. Franklin on "Model Showing Distribution of Electromotive Force and Current Along a Single-phase Alternating-Current Transmission Line."

MODEL SHOWING DISTRIBUTION OF ELECTROMOTIVE FORCE AND CURRENT ALONG A SINGLE-PHASE ALTERNATING-CURRENT TRANSMISSION LINE

W. S. Franklin

Vol. xxi—1903, pp. 261-262

Description of model and interpretation of its meaning.

Discussion (including that of paper by Ralph D. Mershon on "Mechanical Specifications of a Proposed Standard Insulator Pin," paper by F. O. Blackwell on "The Testing of Insulators," paper by P. M. Lincoln on "Transposition and Relative Location of Power and Telephone Wires," and paper by C. C. Chesney on "Burning of Wooden Pins on High-Tension Transmission Lines"), pp. 263-325, by Messrs. C. F. Scott, Ralph

D. Mershon, M. H. Gerry, Jr., Wm. R. C. Corson, W. C. L. Cory, D. L. Huntington, W. N. Smith, P. H. Thomas, P. M. Lincoln, T. W. Shock, F. N. Waterman, C. C. Chesney, W. L. Waters, C. E. Skinner, C. O. Mailloux, C. L. de Muralt, Philip Torchio, J. R. Armstrong, F. S. Woodward, Henry Floy, D. C. Jackson, F. S. Jones, F. A. C. Perrine, —— Hodges, Washington Devereux, Carl Hering, Chas. Hewitt, Jas. T. Hutchins, H. F. Sanville, Thomas Spencer, W. G. Carlton, Ernest Gonzenbach, H. H. Wait, A. H. Hatch, J. R. Cravath, H. Etheridge, P. H. Thomas, J. S. Peck, and Budd Frankenfield.

General discussion of insulator pins—calculation of strength, electrical and mechanical tests, wood vs. iron. Relative merits of glass and porcelain insulators; tests. Telephone line disturbances from high-tension lines.

CHOICE OF FREQUENCY FOR VERY LONG LINES

P. M. Lincoln Vol. xxii—1903, pp. 373-376

General discussion of the relative advantages of 60 and 25 cycles for a 200-mile transmission line as regards voltage regulation, charging current and resonance.

Discussion, pp. 377-384, by Messrs. B. A. Behrend, F. G. Baum, C. F. Scott, C. O. Mailloux, H. G. Stott, Ralph D. Mershon, D. B. Rushmore, P. M. Lincoln, F. A. C. Perrine and H. A. Storrs.

Equation for natural frequency of transmission line with distributed capacity and inductance. Choice of frequency with reference to the operation of the plant as a whole.

THE CONDUCTIVITY OF THE ATMOSPHERE AT HIGH VOLTAGES

Harris J. Ryan Vol. xxiii—1904, pp. 101-134

Analytical discussion of corona phenomena, reviewing previous experiments of the author and others, followed by account of experimental investigation of corona losses in the laboratory with a cathode tube wave tracer, showing effects of conductor dimensions and atmospheric conditions upon critical voltage, all of which are expressed in equation for critical e. m. f.

Discussion, pp. 135-145 and 168-170, by Messrs. C. F. Scott, Samuel Sheldon, Harold B. Smith, P. H. Thomas, Harris J. Ryan, P. M. Lincoln, G. T. Hanchett, Elihu Thomson, Ralph D. Mershon, S. M. Kintner, H. W. Fisher, W. A. Blanck, and C. E. Freeman.

General remarks on losses to atmosphere at high e. m. f.'s, with special reference to the critical e. m. f. and the factors which affect it. Difficulties in measuring very high e. m. f.'s.

OIL SWITCHES FOR HIGH PRESSURES

E. M. Hewlett Vol. xxiii—1904, pp. 215-216

Comparison of oil-break with air-break switches.

Discussion, pp. 217-224, 242-245 and 249-251, by Messrs. C. C. Chesney,

F. A. C. Perrine, Alex Dow, Ralph D. Mershon, C. F. Scott, P. N. Nunn, C. L. de Muralt, H. F. Parshall, W. A. Blanck, James Lyman, P. Junkersfeld, W. G. Carlton, E. O. Sessions, G. N. Eastman, I. E. Brooke, P. H. Thomas, R. F. Schuchardt, Edw. Schildhauer, H. F. Sanville, W. C. L. Eglin.

Experience with oil switches in many large plants. Accounts of tests under short-circuit conditions. Specifications for oil switches and brief reference to some of the mechanical difficulties encountered with present types.

WAVE FORM VARIATIONS OF A LONG-DISTANCE LINE

George H. Rowe Vol. xxiii—1904, pp. 403-415

Oscillographic records of wave form at different parts of the Standard Electric Company's transmission system under various conditions of operation. Observations showing effect of wave distortion on transformer core losses.

Discussion, p. 469, by B. J. Arnold.

CONDITIONS FOR CONTINUOUS SERVICE OVER LINES OPERATED IN PARALLEL

M. H. Gerry, Jr. Vol. xxiii—1904, pp. 547-550

Brief description of method of operating two transmission lines in parallel. Wiring diagram.

Discussion, p. 551, by Messrs. Ralph D. Mershon and P. H. Thomas.

THE TRANSPOSITION OF ELECTRICAL CONDUCTORS

Frank F. Fowle Vol. xxiii—1904, pp. 659-687

Mathematical development of the theoretical inductance and capacity constants of a system of line conductors. Empirical rules for transposition and discussion of method of dealing with problems under various conditions, such as are met in actual practice.

Discussion, p. 689, by Messrs. W. S. Franklin, F. F. Fowle, and W. J. Lansley.

AN EXPERIMENTAL STUDY OF THE RISE OF POTENTIAL ON COMMERCIAL TRANSMISSION LINES DUE TO STATIC DISTURBANCES CAUSED BY SWITCHING, GROUNDING, ETC.

Percy H. Thomas Vol. xxiv—1905, pp. 317-354

Brief statement of the principles underlying resonance phenomena in commercial circuits, followed by record of tests on actual transmission lines, showing effect of connecting circuits under many different conditions of grounding, of resonance and of various static disturbances. Also tests of line losses to air and over insulators.

Discussion (including that of paper by Charles P. Steinmetz on "High-Power Surges in Electric Distribution Systems of Great Magnitude"), pp. 355-369, by Messrs. H. G. Stott, P. N. Nunn, S. M. Kintner, F. A. C.

Perrine, H. W. Fisher, J. W. Lieb, Jr., Samuel Sheldon, Charles P. Steinmetz, and Percy H. Thomas.

General remarks on surges and their probable causes. Description of expedients adopted by the Interborough Rapid Transit Company to avoid high-power surges.

LINE CONSTANTS AND ABNORMAL VOLTAGES AND CURRENTS IN HIGH-POTENTIAL TRANSMISSIONS

Ernst J. Berg Vol. xxvi—1907, pp. 163-178

Equations for calculation of transmission line constants. Theoretical investigation of stresses in electric transmission systems resulting from opening and closing switches, arcing grounds, leaks, etc. Investigation of corona on non-grounded system.

Discussion, p. 178, by Mr. Frank G. Baum.

Voltage rise due to interrupting given current.

SWITCHBOARD PRACTICE FOR VOLTAGES OF 60,000 AND UPWARDS

Stephen Q. Hayes Vol. xxvi—1907, pp. 1333-1357

Brief general discussion of factors which enter into the choice and arrangement of control apparatus in high-tension plants, with special reference to oil switches and circuit breakers. Designs for 60,000 and 100,000-volt stations given to demonstrate the relative space required.

Discussion, pp. 1358-1362, by Messrs. P. M. Lincoln, F. B. H. Paine, D. B. Rushmore, H. W. Buck, J. B. Taylor, William McClellan, W. N. Smith, L. C. Nicholson, S. Q. Hayes, J. H. Finney, F. G. Baum, and Ralph D. Mershon.

Use of extra line wire for emergency service. Method of tying conductors to pin type insulators.

HIGH VOLTAGE MEASUREMENTS AT NIAGARA

Ralph D. Mershon Vol. xxvii—1908, pp. 845-903

Detailed account of tests on high tension lines, covering the losses to atmosphere by corona, leakage over insulators, etc., with various spacings, conductor diameters, frequencies and atmospheric conditions; also the effect of the various factors upon the occurrence of the critical voltage. Most data is presented in graphic form. In conclusion there are 22 items that have a distinct bearing upon the operation of very high-tension lines, and which have been deduced from the results of those tests and those made at Telluride and by Professor Ryan.

Discussion, pp. 904-929, by Messrs. Henry Doherty, Elihu Thomson, Samuel Sheldon, Henry Floy, Chas. P. Steinmetz, Percy H. Thomas, P. M. Lincoln, Carl Hering, Chas. F. Scott, A. E. Kennelly, W. L. Waters, and N. M. Snyder.

General discussion of line and insulator losses at high tension. Definition of critical point and explanation of physical meaning of relation between atmospheric losses and vapor product. Analysis of insulator losses.

THE TESTING OF HIGH VOLTAGE LINE INSULATORS

C. E. Skinner **Vol. xxvii—1908, pp. 945-951**

Proposed specifications for routine and design testing of high-tension line insulators.

Discussion, pp. 952-958, by Messrs. Percy H. Thomas, Ralph D. Mershon, Clayton H. Sharp, E. M. Hewlett, Chas. P. Steinmetz, C. E. Skinner, and N. J. Neall.

General remarks on insulator test specifications, with special reference to methods of making the rain test.

A TRIGONOMETRIC METHOD FOR THE SOLUTION OF ALTERNATING-CURRENT PROBLEMS

Harold Pender **Vol. xxvii—1908, pp. 1397-1424**

Development of a short method for solving alternating-current problems with examples of its application to single-phase and three-phase transmission lines, transformer and induction motors. Tables of reactance capacity, resistance and drop factors for use in such calculations.

Discussion, pp. 1424-1427, by Messrs. Comfort A. Adams, W. A. Del Mar, and L. W. Rosenthal.

Magnitude of errors involved by this method when applied to transmission line calculations.

CONDENSER TYPE OF INSULATION FOR HIGH-TENSION TERMINALS

A. B. Reynders **Vol. xxviii—1909, pp. 209-220**

Theory, construction and tests of special form of high-tension terminal bushing built with alternate layers of metal foil and insulation.

Discussion, pp. 221-268, including that of K. C. Randall's paper on "High-tension Transformers and Protective and Controlling Apparatus for Outdoor Installation," by Messrs. W. S. Moody, Percy H. Thomas, David B. Rushmore, Paul M. Lincoln, E. M. Hewlett, S. Piek, Guido Semenza, A. E. Kennelly, J. S. Peck, Ralph D. Mershon, W. S. Franklin, N. J. Neall, G. Faccioli, C. L. de Muralt, V. D. Moody, M. W. Franklin, A. B. Reynders, Ralph W. Pope, F. G. Baum, O. S. Lyford, Jr., Carl Schwartz, J. B. Whitehead, John J. Frank, W. L. Waters, L. L. Perry, J. N. Kelman, August H. Kruesi, and D. Kos.

General discussion of the advisability of using outdoor transformer and switching stations. Experience with outdoor high-tension apparatus. Theory and calculation of condenser type bushings. Construction of oil and asphalt-filled insulating bushings.

OUTPUT AND REGULATION OF LONG-DISTANCE LINES

Percy H. Thomas **Vol. xxviii—1909, pp. 615-640**

Theoretical discussion of the limitations of energy transmission for long distances, with special reference to the line output, e. m. f. regulation, and line energy loss. Numerical examples of very long lines, show-

ing the effects of varying the conductance and capacity by various artificial methods.

Discussion, incorporated with that of Mr. Percy H. Thomas' paper on "Calculation of High-Tension Line."

CALCULATION OF HIGH-TENSION LINE

Percy H. Thomas **Vol. xxviii—1909, pp. 641-686**

Derivation and explanation of transmission line equations, together with practical examples.

Discussion, pp. 687-723, including discussion of "Output and Regulation of Long-Distance Lines," by Messrs. T. R. Rosebrugh, V. Karapetoff, John B. Taylor, Charles P. Steinmetz, P. M. Lincoln, Ralph D. Mershon, Henry W. Fisher, J. B. Whitehead, Charles F. Scott, A. E. Kennelly, W. A. Del Mar, Percy H. Thomas, and T. Dalmont.

General discussion of long-distance transmission, with several systems of general equations and methods of calculating the performance of long transmission lines. Derivation of wave formula for transmission line calculations.

THE DEVELOPED HIGH TENSION NET-WORK OF A GENERAL POWER SYSTEM

Paul M. Downing **Vol. xxix—1910, pp. 705-719**

Brief description of the Pacific Gas & Electric Company's system, with reference to the method of operation through a load dispatcher and also as to practice regarding connection, care and operation of transformers; construction of large capacity high-tension oil switches; lightning arresters and line insulators.

Discussion, pp. 720-729, by Messrs. Markham Cheever, L. B. Stillwell, L. R. Jorgensen, E. F. Scattergood, W. F. Wells, John Harisberger, P. M. Downing, A. M. Hunt, A. O. Austin, and C. F. Adams.

General remarks on the operation of very large high-tension distribution systems, with special reference to the automatic disconnection of disabled lines; the operation of telephone lines paralleling power lines, and the design of large capacity oil switches.

THE ELECTRIC STRENGTH OF AIR

J. B. Whitehead **Vol. xxix—1910, pp. 1159-1187**

Description and discussion of an experimental investigation of the dielectric strength of air and the formation of corona around cylindrical conductors, showing effects of temperature, pressure, and dimensions and material of the wire on the dielectric strength of air. Description of a new and very accurate method of testing dielectric strength of air about conductors. Bibliography.

Discussion, incorporated with that of Mr. H. W. Tobey's paper on "Dielectric Strength of Oil."

C. ECONOMICS

THE MAXIMUM DISTANCE TO WHICH POWER CAN BE ECONOMICALLY TRANSMITTED

Ralph D. Mershon Vol. xxiii—1904, pp. 759-781

Consideration of the elements which limit the distance to which energy can be transmitted. Curves showing the economical distance for different amounts of energy, different voltages, costs of generators and selling prices. Size of conductors for different distances and powers and profit for different distances and powers. Analysis of the equations in which the costs are expressed in terms of the line constants.

Discussion, pp. 782-806, by Messrs. J. W. Lieb, Jr., Philip Torchio, P. G. Gossler, J. E. Wallace, M. H. Gerry, Jr., A. E. Kennelly, Charles F. Scott, C. L. de Muralt, Ralph D. Mershon, S. M. Kintner, P. M. Lincoln, C. E. Skinner, H. W. Fisher, N. J. Neall, William McClellan, A. B. Stitzer, Carl Hering, and H. A. Foster.

General discussion of the author's results and assumptions. Choice of frequency for long-distance transmission lines. Effect of load-factor on competition of transmission plants with steam plants. Limit of price for which transmitted energy can be sold.

ELECTRIC POWER TRANSMISSION

Frederick Darlington Vol. xxv—1906, pp. 181-190

General classification of natural water powers and loads which may be carried by such powers. Outline of data that must be determined in developing water power. Preliminary data and detailed estimates of cost of energy production in a certain plant in the Southern Appalachian Mountains; also estimated cost of steam competition.

No discussion.

SINGLE-PHASE HIGH-TENSION POWER TRANSMISSION

E. J. Young Vol. xxvi—1907, pp. 1573-1579

Superficial comparison of high-tension direct-current, single-phase with grounded neutral point and three-phase transmission systems on the score of economy.

Discussion, pp. 1580-1583, by Messrs. Charles P. Steinmetz, E. H. Schwarz, C. T. Wilkinson, and G. T. Fielding, Jr.

Comparison of single-phase and polyphase systems with grounded neutral. Armature reactance and short-circuit performance of single-phase generators. Some characteristics of the Thury direct-current system.

SOME ENGINEERING FEATURES OF THE SOUTHERN POWER COMPANY'S SYSTEM

J. W. Fraser Vol. xxvii—1908, pp. 819-840

General discussion of the reasons that govern the choice of power capacity, frequency, voltage, line construction and sub-station equipment in this particular instance. Outline of the company's policy with refer-

ence to the development of secondary power available only part of the year.

Discussion, pp. 841-844, by Messrs. J. H. Finney, W. S. Lee, D. B. Rushmore, P. M. Lincoln, Chas. P. Steinmetz, P. H. Thomas, and J. W. Fraser.

Additional data on the operation of the system. General remarks on the choice of voltage for transmission plants.

14. ELECTRIC SERVICE DISTURBANCES AND PROTECTION

A. PROTECTION OF APPARATUS

REVERSE-CURRENT CIRCUIT-BREAKERS AND THE PROTECTION OF TRANSMISSION LINES

Leonard Wilson **Vol. xxii—1903, pp. 303-309**

General characteristics and principles of operation of reverse-power relays. Description of Andrews' reverse-power indicator and differential choke coils for preventing the establishment of a reverse power.

Discussion, pp. 310-311, by Messrs. H. G. Stott, Leonard Wilson, and Charles F. Scott.

Method of using differential choke coils on any number of parallel feeders.

SAFETY DEVICES IN CENTRAL STATIONS AND SUB-STATIONS

Philip Torchio **Vol. xxi—1903, pp. 417-423**

Itemized list of expedients to be employed in large central station system to insure the maximum degree of reliability of service.

Discussion, incorporated with that of paper by Peter Junkersfeld on "Multiple Versus Independent Operation of Units and Central Stations."

THE USE OF AUTOMATIC MEANS FOR DISCONNECTING DISABLED APPARATUS

H. G. Stott **Vol. xxii—1903, pp. 427-430**

General recommendation for the protection of generators, transmission lines, synchronous converters and feeders, with reverse power and overload relays with and without time and current limit attachments.

Discussion (including that of paper by Henry W. Fisher on "Electric Cables for High Voltage Service," and paper by Philip Torchio on "The Operation and Maintenance of High-Tension Underground Systems"), pp. 431-444, by Messrs. W. F. Wells, Edward P. Burch, Carl Schwartz, W. G. Carlton, W. C. L. Eglin, C. O. Mailloux, Ralph D. Mershon, H. G. Stott, H. W. Fisher, W. L. Waters, R. S. Kelsch, and F. A. C. Perrine.

Experience in the operation of various large high-tension cable systems. General remarks on protection of transmission and distribution plants.

THE USE OF GROUP-SWITCHES IN LARGE POWER PLANTS

L. B. Stillwell **Vol. xxiii—1904, pp. 199-202**

Wiring layout of Manhattan Railway power plant. Illustrating use of group switches, followed by classified advantages and disadvantages of group switches in this particular instance.

Discussion, pp. 204-214, 238-242 and 247-249, by Messrs. Alex Dow, Ralph D. Mershon, H. G. Stott, Lewis B. Stillwell, William B. Jackson, Gilbert Wright, John B. Taylor, H. F. Parshall, W. G. Carlton, J. Junkersfeld, W. A. Blanck, G. N. Eastman, James Lyman, and B. P. Rowe.

General remarks pro and con the use of group switches. Various methods of connecting generators to feeders advocated. Method of clearing short circuit on long lines where power plants are operated in parallel.

THE USE OF GROUND-SHIELDS IN TRANSFORMERS

J. S. Peck Vol. xxiii—1904, pp. 553-554

Description of the nature and purpose of the ground shield and list of objections to its use.

Discussion, pp. 555-556, by Messrs. Ralph D. Mershon, H. C. Wirt, C. E. Skinner, P. H. Thomas, and W. L. Waters.

Objections to ground shield. Advantages of grounded neutral.

TIME-LIMIT RELAYS

George F. Chellis Vol. xxiv—1905, pp. 247-259

Classification of time-limit relays. Ideal requirements of relays for the protection of alternating-current generators, feeders and synchronous converters. Characteristic performance curves of relays under various conditions. Wiring diagrams for relay connections.

Discussion, incorporated with paper by H. W. Buck on "Duplication of Electrical Apparatus to Secure Reliability of Service."

STANDARDIZATION OF ENCLOSED FUSES

H. O. Lacount Vol. xxiv—1905, pp. 893-913

Account of the events that led up to and of the actual work of developing the National Board of Fire Underwriters specification for enclosed fuses. Copy of the specification.

Discussion, pp. 914-918, by Messrs. H. O. Lacount, S. S. Wheeler, L. W. Downes, A. H. Pikler, W. L. Puffer, and H. G. Stott.

Explanation of the cause of potential rise upon blowing of the fuse.

PROTECTION OF THE INTERNAL INSULATION OF A STATIC TRANSFORMER AGAINST HIGH-FREQUENCY STRAINS

Walter S. Moody Vol. xxvi—1907, pp. 1173-1178

Illustrated description of a method of protecting transformers by providing extra insulation on the end turns and bringing out the taps from the center of the winding.

Discussion, incorporated with paper by H. W. Tobey on "Notes on Transformer Testing."

TESTS WITH ARCING GROUNDS AND CONNECTIONS

Ernst J. Berg Vol. xxvii—1908, pp. 741-751

Account of tests with arcing grounds on transformers with single-phase and polyphase connections to study the effect of such grounds under

various conditions and indicate the best methods of protecting transformers.

Discussion, incorporated with paper by Percy H. Thomas on "Critical Study of Lightning Records on Taylor's Falls Transmission Line."

SOME CONSIDERATIONS IN DESIGNING HEAVY CAPACITY FUSES

Louis W. Downes — **Vol. xxviii—1909, pp. 947-969**

Theory, calculation and design of enclosed fuses, with comparative tests of single and multiple-link enclosed fuses under short-circuit conditions. Oscillograms of short-circuit current and e. m. f.

Discussion, pp. 970-974, by Messrs. C. Francis Harding, J. C. Lincoln, W. S. Andrews, A. E. Kennelly, and Louis W. Downes.

Explanation of the function of filling in enclosed fuses, and description of a method of determining energy consumption of fuses without the use of oscillograph.

B. PROTECTION OF LINES AND CABLES

THE OPERATION AND MAINTENANCE OF HIGH-TENSION UNDERGROUND SYSTEMS

Philip Torchio — **Vol. xxii—1903, pp. 421-425**

Brief remarks on the general subject. Record of cable troubles on The New York Edison Company lines. Connections of apparatus for breaking down defective insulation.

Discussion, incorporated with that of paper by H. G. Stott on "The Use of Automatic Means for Disconnecting Disabled Apparatus."

SAFEGUARDS AND REGULATIONS IN OPERATION OF DISTRIBUTING SYSTEMS

W. C. L. Eglin — **Vol. xxii—1903, pp. 747-754**

General specifications for the material and construction of overhead distribution systems so as to attain a high degree of safety in operation. Method of testing pole transformers that are damaged by lightning disturbances.

Discussion (including that of paper by George H. Lukes on "Overhead High-Tension Distributing Systems in Suburban Districts" and paper by E. J. Bechtel on "Automatic Apparatus for Regulating Generator and Feeder Potentials"), pp. 755-765, by Messrs. H. B. Gear, G. T. Hanchett, Ralph D. Mershon, Calvert Townley, P. M. Lincoln, M. P. Ryder, George F. Sever, H. G. Stott, W. C. L. Eglin, A. C. Pratt, C. F. Scott, S. P. Grace, and C. H. Chalmers.

Analysis of accidents which interrupt service of overhead distribution systems and general rules for minimizing them. Construction of lines through trees. Rules for the protection of telephone lines from power lines.

PROTECTION OF CABLES FROM ARCS DUE TO THE FAILURE OF ADJACENT CABLES

W. G. Carlton Vol. xxiii—1904, pp. 471-474

Description of methods of isolating and fire-proofing cables in manholes.

Discussion, pp. 475-479, by Messrs. Ralph D. Mershon, W. F. Wells, H. C. Wirt, W. G. Carlton, H. B. Alverson, E. M. Lake, A. M. Hunt, and J. W. F. Blizard.

General remarks on the protection of high-tension cables in manholes and in power houses. Formulas for fire-proof coverings.

HIGH-POWER SURGES IN ELECTRIC DISTRIBUTION SYSTEMS OF GREAT MAGNITUDE

Charles P. Steinmetz Vol. xxiv—1905, pp. 297-315

Theoretical and mathematical investigation of high-power surge in Manhattan Railway cable distribution system.

Discussion, incorporated with paper by Percy H. Thomas on "An Experimental Study of the Rise of Potential on Commercial Transmission Lines Due to Static Disturbances Caused by Switching, Grounding, Etc."

AN EXPERIMENTAL STUDY OF THE RISE OF POTENTIAL ON COMMERCIAL TRANSMISSION LINES DUE TO STATIC DISTURBANCES CAUSED BY SWITCHING, GROUNDING, ETC.

Percy H. Thomas Vol. xxiv—1905, pp. 317-354

Brief statement of the principles underlying resonance phenomena in commercial circuits, followed by record of tests on actual transmission lines, showing effect of connecting circuits under many different conditions of grounding, of resonance and of various static disturbances. Also tests of line losses to air and over insulators.

Discussion (including that of paper by Charles P. Steinmetz on "High-Power Surges in Electric Distribution Systems of Great Magnitude"), pp. 355-369, by Messrs. H. G. Stott, P. N. Nunn, S. M. Kintner, F. A. C. Perrine, H. W. Fisher, J. W. Lieb, Jr., Samuel Sheldon, Charles P. Steinmetz, and Percy H. Thomas.

General remarks on surges and their probable causes. Description of expedients adopted by the Interborough Rapid Transit Company to avoid high-power surges.

C. LIGHTNING PHENOMENA

STATIC STRAINS IN HIGH TENSION CIRCUITS AND THE PROTECTION OF APPARATUS

Percy H. Thomas Vol. xix—1902, pp. 213-264

Discussion of the nature, causes and effects of disturbances of the potential in a transmission system, such as occur when switches are opened or closed, grounds, short circuits, etc. Description of the mode of operation of the static interrupter and the spark gap lightning arrester with series and shunt resistors. Experimental study of the effects of static disturbances and the degree of protection afforded by choke coils

and static interrupters. Description of mechanical model for demonstrating the travel of waves over a transmission line.

Discussion, pp. 265-276, by Messrs. C. P. Steinmetz, F. O. Blackwell, H. W. Fisher, Philip Torchio, P. H. Thomas, and B. A. Behrend.

Results of investigation of needle gap, showing the effect of sharpness on sparking distance; also results of experimental investigation of high-tension transmission line, showing the effects of switching with oil and air break switches. Mathematical study of distribution of potential stress in model as to time and distance measured from time and position of application.

LIGHTNING PHENOMENA IN ELECTRIC CIRCUITS

Charles P. Steinmetz Vol. xxvi—1907, pp. 401-423

Description and classification of lightning phenomena, its causes, effects and methods of protection, with general discussion of static charges, traveling waves and oscillations.

Discussion, incorporated with paper by E. E. F. Creighton on "New Principles in the Design of Lightning Arresters."

D. LIGHTNING ARRESTERS

THE FUNCTION OF SHUNT AND SERIES RESISTANCE IN LIGHTNING ARRESTERS

Percy H. Thomas Vol. xix—1902, pp. 1021-1034

Principles of operation of low-equivalent lightning arrester. Discussion of the conditions which affect the non-arcing power and experimental determination of laws governing their relations. Brief description of the test apparatus.

Discussion, incorporated with that of paper by Charles Edward Skinner on "Energy Loss in Commercial Insulating Materials when Subjected to High Potential Strains."

SOME EXPERIENCES WITH LIGHTNING PROTECTIVE APPARATUS

Julian C. Smith Vol. xxiv—1905, pp. 935-944

Account of three years' experience on the lines of the Shawinigan Water & Power Company, with special reference to horn gap arrester with and without series resistors.

Discussion, incorporated with that of paper by N. J. Neall on "Performance of Lightning Arresters on Transmission Lines."

NOTE ON LIGHTNING ARRESTERS ON ITALIAN HIGH-TENSION TRANSMISSION LINES

Philip Torchio Vol. xxiv—1905, pp. 945-949

Description of the Gola series lightning arrester and Friese water resistor static discharger.

Discussion, incorporated with that of paper by N. J. Neall on "Performance of Lightning Arresters on Transmission Lines."

PERFORMANCE OF LIGHTNING ARRESTERS ON TRANSMISSION LINES

N. J. Neall Vol. xxiv—1905, pp. 951-981

Account of an extensive practical investigation of lightning arresters in service and of lightning disturbances on a large number of transmission lines using tell-tale papers. Full instructions for the use of tell-tale papers, followed by numerous reproductions of performance records and of tell-tale papers and a discussion of their meaning and of the relative merits of different types of protective apparatus.

Discussion (including that of paper by Julian C. Smith on "Some Experiences with Lightning Protective Apparatus" and paper by Philip Torchio on "Note on Lightning Arresters on Italian High-Tension Transmission Lines"), pp. 982-998, by Messrs. S. S. Wheeler, P. H. Thomas, Charles F. Scott, W. S. Franklin, J. H. Hallberg, H. C. Wirt, H. A. Pikler, H. G. Stott, Philip Torchio, N. J. Neall, Charles P. Steinmetz, and J. B. Taylor.

General remarks on lightning disturbances and lightning protection. Classification of phenomena, apparatus and its functions. Mode of operation of the overhead grounded wire.

SOME EXPERIENCES WITH LIGHTNING AND STATIC STRAINS ON A 33,000-VOLT TRANSMISSION SYSTEM

Farley Osgood Vol. xxv—1906, pp. 349-363

Account of an experience with violent lightning disturbances in the system of the New Milford Power Company, covering results obtained with multigap arresters with series resistor, multigap arresters alone, and multigap arresters with series and shunt resistors.

Discussion, incorporated with paper by H. C. Wirt on "Protective Apparatus for Lightning and Static Strains."

METHODS OF TESTING PROTECTIVE APPARATUS

E. E. F. Creighton Vol. xxv—1906, pp. 365-397

Classification of lightning disturbances with description of laboratory methods of reproducing the various phenomena. Oscillograms, equivalent needle-gap curves and connection diagrams from tests of lightning arresters. Analytical discussion of the various test methods.

Discussion, incorporated with paper by H. C. Wirt on "Protective Apparatus for Lightning and Static Strains."

PROTECTIVE APPARATUS FOR LIGHTNING AND STATIC STRAINS

H. C. Wirt Vol. xxv—1906, pp. 399-426

Experimental investigation of the use of resistors in lightning arresters, leading up to the use of multigap arresters with shunt resistors; also tests showing the actual utility of reactive coils and account of experience with overhead grounded wire.

Discussion (incorporated with paper by Farley Osgood on "Some Experiences with Lightning and Static Strains on a 33,000-volt Trans-

mission Line" and paper by E. E. F. Creighton on "Methods of Testing Protective Apparatus"), pp. 427-451, by Messrs. H. C. Wirt, C. P. Steinmetz, P. H. Thomas, E. E. F. Creighton, J. B. Taylor, N. J. Neall, P. M. Lincoln, Chas. F. Scott, and Farley Osgood.

General remarks on lightning arresters and lightning protection. Physical and mathematical exposition of theory of multigap arrester with shunt resistors.

RECENT INVESTIGATION OF LIGHTNING PROTECTIVE APPARATUS

R. P. Jackson Vol. xxv—1906, pp. 881-900

Theoretical investigation of lightning phenomena by means of mechanical analogies supplemented by tests tending to show the limitations of inductance of choke coils in protecting transformers and the relative value of the different arc suppressing devices—series resistors, fuses and electrolytic cells, as shown by oscillograms.

Dicussion, pp. 901-926, by Messrs. Ralph D. Mershon, Chas. P. Steinmetz, Percy H. Thomas, E. E. F. Creighton, H. B. Alverson, P. M. Lincoln, R. P. Jackson, J. F. Vaughan, A. Henry Pikler, and H. W. Buck.

Explanation of action of choke coil under sudden stress and under high frequency stress, including both its inductance and capacity effects. Suggested form of graded resistance lightning arresters. Equivalent gap determination for lightning arrester resistor units with choke coils and lightning rods on separate poles.

PROTECTION AGAINST LIGHTNING, AND THE MULTI-GAP LIGHTNING ARRESTER

David B. Rushmore and D. Dubois Vol. xxvi—1907, pp. 425-459

Collection of photographs of lightning. Brief discussion of characteristics of horn-gap arrester, water jet arrester, grounded wire and choke coils. Theory of operation and description of construction of multi-gap and low equivalent and graded resistance lightning arresters.

Discussion, incorporated with paper by E. E. F. Creighton on "New Principles in the Design of Lightning Arresters."

NEW PRINCIPLES IN THE DESIGN OF LIGHTNING ARRESTERS

E. E. F. Creighton Vol. xxvi—1907, pp. 461-486

Description and performance characteristics of multi-gap arrester with graded shunt resistor and electrolytic cell arresters. Theory of operation, oscillograms of current and e. m. f. and design features of the different apparatus.

Discussion (including that of paper by Charles P. Steinmetz on "Lightning Phenomena in Electric Circuits" and paper by David B. Rushmore and D. Dubois on "Protection Against Lightning, and the Multi-gap Lightning Arrester"), pp. 487-505, by Messrs. F. A. C. Perrine, Farley Osgood, P. H. Thomas, E. E. F. Creighton, V. G. Converse, D. Dubois, William McClellan, R. P. Jackson, Charles P. Steinmetz, and D. B. Rushmore.

General discussion of the properties of horn-gap, low-equivalent and electrolytic lightning arresters.

PROTECTIVE APPARATUS ENGINEERING

E. E. F. Creighton **Vol. xxvi—1907, pp. 1049-1095**

Glossary of terms used in dealing with lightning phenomena and protective apparatus. Brief discussion of the properties of lightning and characteristics of lightning arresters. Methods of testing lightning arresters so as to fix their various properties. Classification of various types of lightning protective apparatus with short characterization of the limitations and usefulness of each type. General suggestions as to methods of protecting electric plants.

Discussion, incorporated with paper by N. J. Neall on "A Proposed Lightning Arrester Test."

PRACTICAL TESTING OF COMMERCIAL LIGHTNING-ARRESTERS

Percy H. Thomas **Vol. xxvi—1907, pp. 1097-1137**

General classification of lightning disturbances, followed by description of tests and testing apparatus required in determining the serviceability of lightning arresters. Tests suggested for standardization by the Institute. Practical limitation of frequency and energy of discharges in commercial lines. List of Institute papers on lightning phenomena. Test curves showing non-arcing power of multigap arresters and shunting power of resistors.

Discussion, incorporated with paper by N. J. Neall on "A Proposed Lightning Arrester Test."

A PROPOSED LIGHTNING-ARRESTER TEST

N. J. Neall **Vol. xxvi—1907, pp. 1139-1144**

Description of a method of introducing artificial lightning (recurrent surge) into the transmission circuits, with diagrams of connections of various types of transmission systems.

Discussion (including that of paper by E. E. F. Creighton on "Protective Apparatus Engineering" and paper by Percy H. Thomas on "Practical Testing of Commercial Lightning Arresters"), pp. 1145-1154, by Messrs. E. E. F. Creighton, N. J. Neall, Charles P. Steinmetz, P. H. Thomas, W. S. Lee, and Charles E. Waddell.

General remarks on testing of lightning arresters. Actual experience with graded-resistance arrester on star-connected generator.

COMPARATIVE TESTS OF LIGHTNING PROTECTION DEVICES ON THE TAYLOR'S FALLS TRANSMISSION SYSTEM

J. F. Vaughan **Vol. xxvii—1908, pp. 397-41**

Positive data on transmission line protection covering experience with grounded overhead lines, insulator pins, horn-gap and low-equivalent lightning arresters. Complete log and reproduction of tell-tale papers.

Discussion, incorporated with paper by N. J. Neall on "Studies in Lightning Performance, Season 1907."

STUDIES IN LIGHTNING PERFORMANCE, SEASON 1907

N. J. Neall **Vol. xxvii—1908, pp. 421-448**

Analytical study of lightning performance tests on the Taylor's Falls line and on the system of the Presumpscott Electric Company; discussing the nature of lightning phenomena and the effectiveness of protection afforded by lightning rods and different forms of lightning arresters. The present status of the science of lightning protection is briefly summed up in the conclusion. Observed data of lightning performance is given in the Appendix.

Discussion (included with the paper by H. St. Clair Putnam on "Conservation of Power Resources"), pp. 459-467, by Messrs. H. W. Buck, P. M. Lincoln, J. F. Vaughan, P. H. Thomas, V. E. Goodwin, E. E. F. Creighton, H. G. Stott, N. J. Neall, and V. D. Moody.

General remarks on lightning protection, with special reference to the protection value of grounded conductors and horn-gap lightning arresters, and the interpretation of tell-tale papers.

MEASUREMENTS OF LIGHTNING, ALUMINUM LIGHTNING-ARRESTERS, EARTH RESISTANCES, CEMENT RESISTANCES, AND KINDRED TESTS

E. E. F. Creighton **Vol. xxvii—1908, pp. 669-740**

Brief description of instruments of measuring duration, potential, current and frequency of lightning. Account of experimental investigation under actual service conditions with different forms of lightning protective devices. Theory and operation of aluminum lightning-arresters. Experimental study of ground connections with respect to ground resistance, inductance and permanence under various conditions. Complete report of exhaustive investigation of cement and concrete as a resistor under various conditions of moisture and temperature.

Discussion, incorporated with paper by Percy H. Thomas on "Critical Study of Lightning Records on Taylor's Falls Transmission Line."

CRITICAL STUDY OF LIGHTNING RECORDS ON TAYLOR'S FALLS TRANSMISSION LINE

Percy H. Thomas **Vol. xxvii—1908, pp. 755-777**

Formation of rules for the interpretation of tell-tale papers. Analyses of the storms and the effectiveness of the protection afforded by the various devices—grounded wires, lightning rods, line choke-coils, low equivalent, horn-gap and electrolytic lightning arresters. Explanation of the origin and nature of lightning phenomena.

Discussion (included with the paper by E. E. F. Creighton on "Measurements of Lightning, Aluminum Lightning-Arresters, Earth Resistances, Cement Resistances and Kindred Tests," and paper by Ernst J. Berg on "Tests with Arcing Grounds and Connections"), pp. 778-800, by Messrs. J. V. Vaughan, Chas. P. Steinmetz, Paul M. Lincoln, A. E. Kennelly, John B. Taylor, R. H. Marriott, D. B. Rushmore, J. W. Fraser,

W. L. Waters, William McClellan, Farley Osgood, Dugald C. Jackson, E. E. F. Creighton, E. J. Berg, and Percy H. Thomas.

General remarks on the nature of lightning and methods of protecting electrical installations.

SURGES ON A CABLE SYSTEM WITH AN ALUMINUM SURGE PROTECTOR

E. E. F. Creighton and S. D. Sprong — **Vol. xxviii—1909, pp. 805-839**

Experimental investigation with oscillograms of surges on the underground alternating-current distribution system of the United Electric Light & Power Co. of New York with and without aluminum surge protectors.

Discussion, pp. 840-849, by Messrs. J. L. R. Hayden, H. W. Fisher, John B. Taylor, Ralph D. Mershon, Charles P. Steinmetz, and E. E. F. Creighton.

Theoretical investigation of the action of the aluminum cell in by-passing a surge. Types, construction, operation and care of aluminum cells.

PROTECTION OF ELECTRICAL EQUIPMENT

Paul M. Lincoln — **Vol. xxviii—1909, pp. 1157-1167**

Explanation of action of surges by means of hydraulic analogy, concluding with classification and brief discussion of various methods of protection.

No discussion.

E. GROUNDED CONDUCTORS

THE GROUNDED WIRE AS A PROTECTION AGAINST LIGHTNING

Ralph D. Mershon — **Vol. xxii—1903, pp. 331-336**

Outline of theory of static induction in transmission lines from lightning. Effect of grounded wires and method of calculating the magnitude of the shielding action of such wires. General remarks on installation and operation of such wires.

Discussion, pp. 337-351, by Messrs. Charles F. Scott, F. A. C. Perrine, C. O. Mailloux, A. I. Wurts, P. H. Thomas, A. E. Kennelly, P. M. Lincoln, F. S. Woodward, D. B. Rushmore, R. S. Kelsch, John F. Kelly, R. F. Hayward, W. L. Waters, D. C. Jackson, Ralph D. Mershon, W. J. Hammer, and W. A. Blanck.

General discussion of the probable performance of overhead grounded wire as protection against external electrostatic disturbances.

THE PROTECTION OF HIGH-PRESSURE TRANSMISSION LINES FROM STATIC DISCHARGES

H. C. Wirt — **Vol. xxiii—1904, pp. 557-560**

Brief general remarks on overhead ground wire, lightning arrester and reactive coils.

Discussion, pp. 561-570, by Messrs. J. S. Peck, Ralph D. Mershon, N. J.

Neall, F. O. Blackwell, H. C. Wirt, R. F. Hayward, P. H. Thomas, N. M. Snyder, and John Pearson.

General remarks on lightning protection apparatus and lightning phenomena. Experiences with protective devices and ground wires. Description of method of protecting transformers and windings from potential rises.

POTENTIAL STRESSES AS AFFECTED BY OVERHEAD GROUNDED CONDUCTORS

R. P. Jackson Vol. xxvi–1907, pp. 873-882

Theoretical investigation of potential gradients on equipotential surfaces about grounded conductors in air and about metallic transmission towers. Suggested method of reducing normal stresses in insulators.

Discussion, pp. 883-889, by Messrs. P. M. Lincoln, Dugald C. Jackson, D. R. Scholes, H. C. Hoagland, R. P. Jackson, James Lyman, P. B. Woodworth, W. L. Abbott, W. B. Jackson, and George Hayler.

Experience with grounded conductors for transmission line protection.

NOTES ON RESISTANCE OF GAS-PIPE GROUNDS

J. L. R. Hayden Vol. xxvi—1907, pp. 1209-1214

Tests on resistance of gas pipe grounds as affected by temperature and rain. Graphic log of tests extending over about three years. Effect of alternating current on conductance of ground connections.

Discussion, pp. 1215-1220, by Messrs. Charles P. Steinmetz, Ralph D. Mershon, F. B. H. Paine, P. H. Thomas, N. J. Neall, F. J. Hoxie, and J. L. R. Hayden.

Tests on the resistance of concrete foundations of transmission towers and of ground plates, strips and pipes under various conditions.

LIGHTNING-RODS AND GROUNDED CABLES AS A MEANS OF PROTECTING TRANSMISSION LINES AGAINST LIGHTNING

Norman Rowe Vol. xxvi—1907, pp. 1239-1248

Description of Guanajuato transmission line with account of experience with lightning rods and grounded wire.

Discussion (including that of paper by D. R. Scholes on "Transmission Line Towers and Economical Spans"), pp. 1249-1257, by Messrs. William Hoopes, P. H. Thomas, W. S. Lee, F. B. H. Paine, C. W. Ricker, George T. Fielding, Jr., N. J. Neall, Ralph D. Mershon, D. R. Scholes, Frank G. Baum, and Farley Osgood.

Effect of operation cost on economical span. Experience with grounded metal insulator pins and with wooden pins.

THE GROUNDED NEUTRAL, WITH AND WITHOUT SERIES RESISTANCE IN HIGH-TENSION SYSTEMS

Paul M. Lincoln Vol. xxvi—1907, pp. 1585-1595

General discussion of the advantages and disadvantages of the grounded neutral, followed by brief remarks on the making of grounds and the effect of series resistance in the ground circuit.

Discussion, incorporated with paper by George I. Rhodes on "Experience with a Grounded Neutral on the High-Tension System of the Interborough Rapid Transit Company."

THE GROUNDED NEUTRAL

F. G. Clark — Vol. xxvi—1907, pp. 1597-1603

Some advantages and disadvantages of grounded neutral from experience gained on a large system operated with neutral grounded through a resistor.

Discussion, incorporated with paper by George I. Rhodes on "Experience with a Grounded Neutral on the High-Tension System of the Interborough Rapid Transit Company."

EXPERIENCE WITH A GROUNDED NEUTRAL ON THE HIGH-TENSION SYSTEM OF THE INTERBOROUGH RAPID TRANSIT COMPANY

George I. Rhodes — Vol. xxvi—1907, pp. 1605-1610

Reasons for installing grounded neutral with series resistor on high-tension cable system. Cross currents between star-connected generators. Relative damage resulting from cable short circuits with and without grounded neutral.

Discussion (including that of paper by Paul M. Lincoln on "The Grounded Neutral, with and without Series Resistance, in High-Tension Systems" and that of paper by F. G. Clark on "The Grounded Neutral"), pp. 1611-1641, by Messrs. Peter Junkersfeld, Philip Torchio, N. J. Neall, John B. Taylor, Carl Schwarz, C. W. Stone, F. B. H. Paine, Charles F. Scott, Paul M. Lincoln, George I. Rhodes, Charles P. Steinmetz, Frank G. Baum, and O. S. Lyford, Jr.

Experience with grounded neutral on very large underground cable and overhead transmission systems. Description of device for automatically selecting and disconnecting defective cables.

A PRACTICAL METHOD OF PROTECTING INSULATORS FROM LIGHTNING AND POWER ARC EFFECTS

L. C. Nicholson — Vol. xxix—1910, pp. 573-598

Very complete analytical study of three years of carefully recorded insulator experience on 60,000-volt lines of the Ontario Power Company, leading up to the invention of arcing rings and covering one season's experience with them installed.

Discussion, pp. 599-620, by Messrs. L. B. Stillwell, F. P. Catchings, J. W. Fraser, E. E. F. Creighton, J. S. Jenks, Charles F. Scott, Percy H. Thomas, J. A. Sanford, Jr., E. B. Merriam, Harris J. Ryan, Irving E. Brooke, James Lyman, Max H. Collbohm, G. Semenza, J. D. E. Duncan, and L. C. Nicholson.

General remarks on transmission line protection. Experience on the West Penn lines (185 miles). Opinions and practice as to insulator factor of safety and efficacy of grounded conductors.

15. DISTRIBUTION SYSTEMS

THE DISTRIBUTION AND CONVERSION OF RECEIVED CURRENTS

Henry Gordon Stott Vol. xviii—1901, pp. 125-152

Brief description of the transmission plant for generation, transformation and transmission of electric energy from Niagara Falls to Buffalo. Discussion of operative features: means adopted for the protection of the system; relative merits of synchronous converters and motor-generators; relative merits of various arc lighting systems; difficulties in synchronizing 60-cycle synchronous motors.

Discussion, pp. 153-163, by Messrs. Gano S. Dunn, Calvin W. Rice, H. G. Stott, C. P. Steinmetz, Elias E. Ries, Jos. Sachs, Jno. W. Lieb, Jr., and H. D. Reed.

Characteristics of three-phase induction motors for railway service. Relative performance of air-break and oil-break switches. Experiences with rubber-insulated high-voltage cables.

THE DISTRIBUTION BY THE THREE-PHASE SYSTEM AND THE OPERATION OF SINGLE-PHASE CIRCUITS BY IT

W. L. R. Emmet Vol. xviii—1901, pp. 805-812

Discussion of the use of three-phase generators on single distribution circuits. Wiring diagram for typical systems. General rules for laying out distribution systems.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

DISTRIBUTION OF ELECTRICAL ENERGY IN LARGE CITIES

Louis A. Ferguson Vol. xviii—1901, pp. 813-827

General discussion of the load characteristics of the City of Chicago and description of the present system of generation and distribution and the plans for future development. Brief reference to the distribution systems employed in the cities of Berlin and Milan.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

LOCATING FAULTS IN UNDERGROUND DISTRIBUTION SYSTEMS

Henry G. Stott Vol. xviii—1901, pp. 829-833

Description of a compass method for quickly and accurately locating faults in power cables through which periodically reversed current is sent. Working drawings of the current reverser.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

THE BUFFALO HIGH-TENSION CABLE DISTRIBUTION SYSTEM

Harold W. Buck — Vol. xviii—1901, pp. 835-841

General description of system of distribution of Niagara power in Buffalo.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

ALTERNATING CURRENT AS A FACTOR IN GENERAL DISTRIBUTION FOR LIGHT AND POWER

Charles P. Scott — Vol. xviii—1901, pp. 843-848

General discussion of the advantages of straight alternating-current generation and distribution for large cities.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

NOTES ON THE ALTERNATING-CURRENT SYSTEM OF DISTRIBUTION

W. S. Barstow — Vol. xviii—1901, pp. 849-853

Brief sketch of the development of alternating-current distribution system and troubles which were experienced. Conditions which must be met by successful alternating-current distribution system.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

DISTRIBUTION OF ELECTRICITY IN CITIES OF MODERATE SIZE

William Lispenard Robb — Vol. xviii—1901, pp. 855-860.

General consideration of problem for cities under 50,000 and for those over 50,000.

Discussion, incorporated with that of paper by Philip Torchio on "250-Volt Three-Wire Distribution for Lighting and Power."

250-VOLT THREE-WIRE DISTRIBUTION FOR LIGHTING AND POWER

Philip Torchio — Vol. xviii—1901, pp. 861-868

Consideration of the relative merits of 500-volt and 250-volt direct-current three-wire systems. Estimated saving of former over latter—with the various densities of load.

Discussion (including that of paper by W. L. R. Emmet on "Distribution of Three-Phase System and the Operation of Single-Phase Circuits by It;" paper by Louis A. Ferguson on "Distribution of Electrical Energy in Large Cities;" paper by Henry G. Stott on "Locating Faults in Underground Distribution Systems;" paper by Harold W. Buck on "The Buffalo High-Tension Cable System;" paper by Chas. F. Scott on "Alternating Current as a Factor in General Distribution for Light and Power;" paper by W. S. Barstow on "Notes on an Alternating-Current System of Distribution," and paper by William Lispenard Robb on "Distribution of Electricity in Cities of Moderate Size"), pp. 869-912, by Messrs. C. P. Steinmetz, Gano S. Dunn, Louis A. Ferguson, Arthur Williams, Douglas

Burnett, Fred. V. Henshaw, Jno. W. Lieb, Jr., W. S. Barstow, Philip Torchio, R. H. Pierce, Peter Junkersfeld, Jas. Lyman, A. Osthoff, G. N. Eastman, P. B. Woodworth, G. A. Damon, Geo. Foster, W. D. Ball, J. R. Cravath, D. W. Roper, and W. E. Goldsborough.

General discussion of the relative merits of alternating-current and direct-current distribution for thickly populated districts of large cities. Detailed comparison of the performance and general methods of direct-current and induction motors for different kinds of service. Loop test for locating faults in large cables.

OVERHEAD HIGH-TENSION DISTRIBUTING SYSTEMS IN SUBURBAN DISTRICTS.

George H. Lukes **Vol. xxii—1903, pp. 735-739**

General discussion of the construction and operation of a satisfactory distribution system for suburban towns and villages surrounding a large city.

Discussion, incorporated with that of paper by W. C. L. Eglin on "Safeguards and Regulations in Operation of Overhead Distributing Systems."

AUTOMATIC APPARATUS FOR REGULATING GENERATOR AND FEEDER POTENTIALS

E. J. Bechtel **Vol. xxii—1903, pp. 741-745**

Performance under service conditions of automatic direct-current and alternating-current generator e. m. f. regulator which operates by decreasing and increasing the field circuit resistance with changes in line e. m. f.

Discussion, incorporated with that of paper by W. C. L. Eglin on "Safeguards and Regulations in Operation of Overhead Distributing Systems."

SAFEGUARDS AND REGULATIONS IN OPERATION OF DISTRIBUTING SYSTEMS

W. C. L. Eglin **Vol. xxii—1903 pp. 747-754**

General specifications for the material and construction of overhead distribution systems so as to attain a high degree of safety in operation. Method of testing pole transformers that are damaged by lightning disturbances.

Discussion (including that of paper by George H. Lukes on "Overhead High-Tension Distributing Systems in Suburban Districts" and paper by E. J. Bechtel on "Automatic Apparatus for Regulating Generator and Feeder Potentials"), pp. 755-765, by Messrs. H. B. Gear, G. T. Hanchett, Ralph D. Mershon, Calvert Townley, P. M. Lincoln, M. P. Ryder, George F. Sever, H. G. Stott, W. C. L. Eglin, A. C. Pratt, C. F. Scott, S. P. Grace, and C. H. Chalmers.

Analysis of accidents which interrupt service of overhead distribution systems and general rules for minimizing them. Construction of lines through trees. Rules for the protection of telephone lines from power lines.

UNDERGROUND TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY

Charles E. Phelps Vol. xxvi—1907, pp. 25-30

Classification of cable faults, followed by seven-year record of the performance of various kinds of power, telephone and telegraph cables. Brief analytical discussion of the causes and remedies for these various faults.

No discussion.

AN ANALYSIS OF THE DISTRIBUTION LOSSES IN A LARGE CENTRAL STATION SYSTEM

L. L. Elden Vol. xxvi—1907, pp. 665-680

Record of four years' study of the losses in a certain large energy distribution system, with an account of methods employed to reduce losses between switchboard and consumer.

No discussion.

ALTERNATING-CURRENT FEEDER REGULATORS

W. S. Moody Vol. xxvii—1908, pp. 255-272

Classification and brief discussion of the relative merits of different methods of feeder e. m. f. regulation, followed by description of the construction and operative characteristics of the transformer and induction type regulators. A brief outline of the development of automatic control and description of applications of the Tirrill contact voltmeter to the control of feeder regulators.

Discussion, pp. 273-275, by Messrs. R. G. Black, J. Kynoch and R. S. Kelsch.

Experience with the Tirrill and induction type regulators.

HIGH-POTENTIAL UNDERGROUND TRANSMISSION

P. Junkersfeld and E. O. Schweitzer Vol. xxvii—1908, pp. 1499-1527

Description of the underground cable system of the Commonwealth Edison Company of Chicago with records of its performance and results of experiments to determine the magnitude and frequency of occurrence of potential rises in the system.

Discussion, pp. 1528-1569, by Messrs. L. A. Ferguson, Charles H. Merz, H. W. Fisher, H. G. Stott, E. J. Berg, Wallace S. Clark, Alex Dow, Warren Partridge, E. E. F. Creighton, L. T. Robinson, Henry Floy, John W. Lieb, Jr., Philip Torchio, Charles P. Steinmetz, E. O. Schweitzer, Peter Junkersfeld, Ralph D. Mershon, H. W. Peck, A. E. Kennelly, N. J. Neall, L. L. Elden, M. V. Ayres, G. W. Palmer, Jr., and Dugald C. Jackson.

Cable experience of various large central stations and transmission companies.

CONDITIONS AFFECTING STABILITY IN ELECTRIC LIGHTING CIRCUITS

Elihu Thomson **Vol. xxviii—1909, pp. 1-22**

Historical résumé of the development of arc lighting machines and systems. Characteristics of arc dynamos; constant-current transformers; mercury arc converters; constant-current and constant-potential arc lamps with special reference to stability of operation.

Discussion, pp. 23-50, by Messrs. A. E. Kennelly, Alex Dow, E. W. Rice, Jr., Dugald C. Jackson, C. M. Green, John B. Taylor, H. G. Stott, Elihu Thomson, E. A. Sperry, and Charles P. Steinmetz.

Early experiences with arc lighting systems. Broad definition and examples of various kinds of electrical and mechanical instability. Permanent and transient volt-ampere characteristics of arcs.

HIGH-VOLTAGE TRANSFORMERS AND PROTECTIVE AND CONTROLLING APPARATUS FOR OUTDOOR INSTALLATION

K. C. Randall **Vol. xxviii—1909, pp 189-207**

Description of types of apparatus, with estimates of relative costs of outdoor and indoor installations. Operation of outdoor transformer stations.

Discussion, incorporated with that of A. B. Reynders' paper on "Condenser Type of Insulation for High-Tension Terminals."

THE DEVELOPED HIGH TENSION NET-WORK OF A GENERAL POWER SYSTEM

Paul M. Downing **Vol. xxix—1910, pp. 705-719**

Brief description of the Pacific Gas & Electric Company's system, with reference to the method of operation through a load dispatcher and also as to practice regarding connection, care and operation of transformers; construction of large capacity high-tension oil switches; lightning arresters and line insulators.

Discussion, pp. 720-729, by Messrs. Markham Cheever, L. B. Stillwell, L. R. Jorgensen, E. F. Scattergood, W. F. Wells, John Harisberger, P. M. Downing, A. M. Hunt, A. O. Austin, and C. F. Adams.

General remarks on the operation of very large high-tension distribution systems, with special reference to the automatic disconnection of disabled lines; the operation of telephone lines paralleling power lines, and the design of large capacity oil switches.

16. CONTROL REGULATION AND SWITCHING

A. SPEED CONTROL

SPEED REGULATION OF PRIME MOVERS PARALLEL OPERATION OF ALTERNATORS

Charles P. Steinmetz — Vol. xviii—1901, pp. 741-744

Brief consideration of the features of speed regulation that affect parallel operation of alternators.

Discussion, incorporated with that of paper by W. I. Slichter on "Angular Velocity in Steam Engine in Relation to Paralleling of Alternators."

PARALLEL OPERATION OF ENGINE-DRIVEN ALTERNATORS

W. L. R. Emmet — Vol. xviii—1901, pp. 745-751

Account of the development of an anti-surging device for application to engine governors to enable parallel operation of alternators under all conditions of load.

Discussion, incorporated with that of paper by W. I. Slichter on "Angular Velocity in Steam Engine in Relation to Paralleling of Alternators."

A NOVEL COMBINATION OF POLYPHASE MOTORS FOR TRACTION PURPOSES

Ernst Danielson — Vol. xix—1902, pp. 527-539

Description of a system of concatenating two motors of unequal numbers of poles so as to get four running speeds. Comparison of acceleration characteristics, torque, energy, efficiency, etc., with direct-current series, plain induction and concatenated induction motors. Abstracted by Dr. Chas. P. Steinmetz on page 495.

Discussion (including that of paper by Carl L. DeMuralt on "Some Notes on European Practice in Electric Traction with Three-Phase Alternating Current"), pp. 540-555, by Messrs. C. P. Steinmetz, C. O. Mailloux, Henry G. Stott, W. N. Smith, W. J. Hammer, Townsend Wolcott, Frederick V. Henshaw, and C. L. DeMuralt.

A VARIABLE RELUCTANCE METHOD OF MOTOR SPEED CONTROL

G. Fred Packard — Vol. xix—1902, pp. 1131-1141

Reference to earliest work in this direction. Description of the Johnson method of varying the reluctance at the pole face, while maintaining the commutating fringe. Performance tests and flux distribution curves of a Stow motor built on these principles.

Discussion, pp. 1142-1143, by Chas. P. Steinmetz, William Esty, G. Fred Packard, P. H. Thomas, and E. B. Raymond.

VARIABLE SPEED MOTOR CONTROL

Vol. xx—1902, pp. 111-114

Introduction by President Chas. F. Scott.

THREE-WIRE SYSTEM FOR VARIABLE SPEED MOTOR WORK

N. W. Storer — Vol. xx—1902, pp. 127-133

Description of the operation of adjustable speed motors from three-

wire generator, giving advantages of the system and the range of speed variation when combined field and armature control are used.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous Current Motors for Machine Tools."

THE STORAGE BATTERY AS A FACTOR IN SPEED CONTROL

H. P. Coho Vol. xx—1902, pp. 135-138

Brief description of electric drive for Hoe printing press, using storage battery for multi-voltage.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous Current Motors for Machine Tools."

A SERIES-PARALLEL SYSTEM OF SPEED CONTROL

Geo. W. Fowler Vol. xx—1902, pp. 143-153

Description of controller and its mode of operation as applied to double commutator driving Webb press.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous Current Motors for Machine Tools."

CONTINUOUS-CURRENT MOTORS FOR MACHINE TOOLS

F. O. Blackwell Vol. xx—1902, pp. 159-165

Power characteristics and requirements of various classes of machine tools. Brief mention of the different methods of speed control of electric motors and the advantages and limitations of each.

Discussion (including that of paper by R. T. E. Lozier on "The Operation of Machine Shops by Individual Electric Motors;" paper by N. W. Storer on "Three-Wire System for Variable Speed Motor Work;" paper by H. B. Coho on "The Storage Battery as a Factor in Speed Control;" paper by P. O. Keilholtz on "Electrically Operated Coal Hoist Having Variable Speed Control;" paper by Geo. W. Fowler on "A Series-Parallel System of Speed Control," and paper by H. Ward Leonard on "Multiple-Unit, Voltage Speed Control for Trunk Line Service"), pp. 166-195, by Messrs. Gano S. Dunn, Chas. F. Scott, H. E. Heath, S. T. Dodd, Arthur Williams, Philip Lange, Chas. Day, R. T. E. Lozier, N. W. Storer, H. Ward Leonard, Herbert Dowe, H. B. Coho, Geo. A. Damon, R. W. Stovel, Geo. B. Dusinberre, W. A. Dick, P. M. Lincoln, —— Campbell, Chas. G. Winslow, E. M. Tingley, —— Stevenson, —— Barr, R. H. Pierce, Peter Junkersfeld, O. E. Osthoff, D. C. Jackson, B. J. Arnold, G. B. Foster, Ernest Gonzenbach, V. R. Lansingh, H. H. Cutler, F. J. Pearson, and H. R. King.

Relative merits of various methods of speed control of direct-current motors. Conditions which determine the choice between individual and group drive. Effects of motor drive and suitable speed control on shop efficiency. Advantages and disadvantages of the Ward-Leonard system of locomotive driven from single-phase circuits.

METHODS OF SPEED CONTROL

Wm. Cooper Vol. xx—1902, pp. 197-213

Outline of the general power requirements of the different classes of machine tools. Description of method of choosing proper size of motor

for given service and speed range from a speed horse-power diagram for combining multiple voltage and field regulation; numerical examples. Set of general rules for determining motor size.

No discussion.

A NEW METHOD OF TURBINE CONTROL

Lamar Lyndon Vol. xxv—1906, pp. 165-177

Theory and description of a water wheel governor designed to compensate pressure rises in pipe systems and to prevent overrunning.

Discussion, pp. 178-179, by Messrs. Paul Spencer, Lamar Lyndon and Carl Hering.

GAS-ENGINE REGULATION FOR DIRECT-CONNECTED UNITS

Charles E. Lucke Vol. xxvi—1907, pp. 1-24

General discussion of speed regulation problems, defining the function of governors, fly-wheels and valve gears, and listing the variables that enter into the problem. The use of crank-pin force and speed diagrams, in the solution of such problems, is suggested and its application to steam turbine operation used as an illustration. A number of papers before the A. I. E. E. and A. S. M. E. on this subject are abstracted and commented upon.

No discussion.

REGENERATION OF POWER WITH SINGLE-PHASE ELECTRIC RAILWAY MOTORS

William Cooper Vol. xxvi—1907, pp. 1469-1480

General requirements and motor characteristics necessary for successful regenerative control. Theory of regenerative control of single-phase series motors with examples of its practical applications.

Discussion, pp. 1481-1484, by Messrs. W. I. Slichter, L. B. Stillwell, J. C. Lincoln, and William Cooper.

Compounding effect utilized to improve power-factor of returned energy. Advantages of regenerative control.

ELECTRIC CONTROL FOR ROLLING MILL MOTORS

C. F. Henderson Vol. xxviii—1909, pp. 897-912

Brief outline of essential requirements of controllers for motors operating ore handling machinery and rolling mills, with description of contactor type controller and various applications of automatic controllers in and about a steel mill.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

AUTOMATIC MOTOR CONTROL

H. E. White Vol. xxviii—1909, pp. 913-920

Advantages and operative characteristics of contactor switch, and description of various systems of automatic control; current limit; counter e. m. f.; time limit, and pilot motor.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

B. E. M. F. REGULATION

A METHOD OF COMPOUNDING ALTERNATING-CURRENT GENERATORS AND MOTORS, DIRECT-CURRENT GENERATORS, SYNCHRONOUS MOTOR-GENERATORS AND SYNCHRONOUS CONVERTERS

Frank George Baum **Vol. xix-1902, pp. 745–757**

Description of original methods of compounding alternating-current generators, synchronous motors, direct-current generators, synchronous converters, synchronous motor-generators and transmission systems. Use of the Baum regulation diagram.

Discussion, incorporated with that of paper by Chas. P. Steinmetz on "Notes on the Theory of the Synchronous Motor."

THE DETERMINATION OF ALTERNATOR CHARACTERISTICS

Louis A. Herdt **Vol. xix—1902, pp. 1093–1121**

Analytical and experimental study of alternator characteristics with description of different methods for determining regulation. Results of calculations checked with tests on inductor and revolving-field types of machines. Diagrams of the magnetic circuits of the machines tested, and many test curves of load and saturation characteristics, flux distribution, etc.

No discussion.

THE EXPERIMENTAL BASIS FOR THE THEORY OF THE REGULATION OF ALTERNATORS

B. A. Behrend **Vol. xxi—1903, pp. 497–517**

Experimental study of regulation of alternators indicating an approximate method of determining the regulation from the combination of the Behn-Eschenburg or e. m. f. method and the Institute or ampere-turn method.

THE COMPOUNDING OF SELF-EXCITED ALTERNATING-CURRENT GENERATORS FOR VARIATION IN LOAD AND POWER-FACTOR

A. S. Garfield **Vol. xxi—1903, pp. 569–577**

Description of the compounding and compensating characteristics of the Latour self-exciting alternator with brushes in different positions on both inductive and non-inductive loads.

Discussion, pp. 578-587, by Messrs. C. F. Scott, B. A. Behrend, C. A. Adams, Gano S. Dunn, W. L. Waters, J. R. Armstrong, Marius Latour, P. M. Lincoln, V. Karapetoff, ——— Schmit, J. S. Peck, and E. Molin.

General remarks on importance of specifying regulation and on methods of estimating it. Latour method of compounding alternators.

AUTOMATIC APPARATUS FOR REGULATING GENERATOR AND FEEDER POTENTIALS

E. J. Bechtel **Vol. xxii—1903, pp. 741–745**

Performance under service conditions of automatic direct-current and alternating-current generator e. m. f. regulator which operates by decreasing and increasing the field circuit resistance which changes in line e. m. f.

Discussion, incorporated with that of paper by W. C. L. Eglin on "Safeguards and Regulations in Operation of Overhead Distributing Systems."

A CONTRIBUTION TO THE THEORY OF THE REGULATION OF ALTERNATORS

H. M. Hobart and F. Punga — Vol. xxiii—1904, pp. 291-322

Theoretical investigation of armature reaction in singlephase and polyphase generator, development of method of calculating the regulation and excitation from the design constants of the machine. Actual tests of accuracy of the method in given instances. Complete design data given for the machines tested. Derivation of all new formulas.

Discussion (including that of paper by David B. Rushmore on "The Mechanical Construction of Revolving-Field Alternators"), pp. 323-343, by Messrs. C. A. Adams, Jr., B. A. Behrend, W. L. Waters, Gano S. Dunn, David B. Rushmore, F. A. C. Perrine, Bradley T. McCormick, V. Karapetoff, H. M. Hobart, and Franklin Punga.

Discussion of analytical and graphical methods of calculating exciting current and regulation from design data and experimental data.

SYNCHRONOUS MOTORS FOR REGULATION OF POWER-FACTOR AND LINE PRESSURE

B. G. Lamme — Vol. xxiii—1904, pp. 481-492

Discussion of factors which enter into the design of synchronous motor for power-factor regulation. Application of synchronous motors as regulators and as combined motor and regulator. General remarks on power-factor regulation, use of synchronous converters, cost of synchronous motor regulation, choice of location of regulator, etc.

Discussion, pp. 494-510, by Messrs. F. O. Blackwell, W. L. Waters, H. B. Gear, W. B. Jackson, F. A. C. Perrine, Ralph D. Mershon, S. B. Storer, Charles F. Scott, J. S. Peck, H. W. Buck, and T. J. Johnston.

General remarks on power-factor and e. m. f. regulation with synchronous motors. Description of methods of automatically adjusting the excitation of the synchronous motor.

SOME DEVELOPMENTS IN SYNCHRONOUS CONVERTERS

Chas. W. Stone — Vol. xxvii—1908, pp. 181-189

Description of some mechanical details of the vertical type synchronous converter. Brief discussion of the advantages and disadvantages of different methods of voltage regulation including the booster and the split-pole methods.

Discussion, incorporated with paper by J. E. Woodbridge on "Some Features of Railway Converter Design and Operation."

ALTERNATING-CURRENT FEEDER REGULATORS

W. S. Moody — Vol. xxvii—1908, pp. 255-272

Classification and brief discussion of the relative merits of different methods of feeder e. m. f.'s, followed by description of the construction and operative characteristics of the transformer and induction type regulators. A brief outline of the development of automatic control and description of applications of the Tirrill contact voltmeter to the control of feeder regulators.

Discussion, pp. 273-275, by Messrs. R. G. Black, J. Kynoch, and R. S. Kelsch.

Experience with the Tirrill and induction type regulators.

VOLTAGE RATIO IN SYNCHRONOUS CONVERTERS WITH SPECIAL REFERENCE TO THE SPLIT-POLE CONVERTER

Comfort A. Adams — Vol. xxvii—1908, pp. 959-985

Determination of e. m. f. wave form from the harmonic analysis of the flux distribution curve. The method is fully developed and then applied to two and three-part pole converters.

Discussion, incorporated with paper by J. L. Woodbridge on "Application of Storage Batteries to Regulation of Alternating-Current Systems."

APPLICATION OF STORAGE BATTERIES TO REGULATION OF ALTERNATING-CURRENT SYSTEMS

J. L. Woodbridge — Vol. xxvii—1908, pp. 987-1021

Brief general discussion of the various types of service where storage batteries can be used to regulate the alternating current load, including brief descriptions of some typical plants. Detailed description of the use of storage batteries with carbon regulator, split-pole converter and synchronous exciter, with analysis of performance. Analysis and oscillograms of e. m. f. waves of three-part and two-part pole converters. A general solution for the e. m. f. wave-form and two-part pole converter.

Discussion (including paper by Comfort A. Adams on "Voltage Ratio in Synchronous Converters, with Special Reference to the Split-Pole Converters"), pp. 1022-1055, by Messrs. P. M. Lincoln, A. S. Hubbard, W. L. Waters, Charles P. Steinmetz, J. L. Burnham, J. L. Woodbridge, and G. E. Brown.

General discussion of the performance characteristics of the split-pole converter, with physical exposition of the method of varying the voltage ratio and its effect on armature reaction, heating and commutation. Data from tests in commercial operation.

CONDITIONS AFFECTING STABILITY IN ELECTRIC LIGHTING CIRCUITS

Elihu Thomson — Vol. xxviii—1909, pp. 1-22

Historical resume of the development of arc lighting machines and systems. Characteristics of arc dynamos, constant-current transformers, mercury-arc converters, constant-current and constant-potential arc lamps with special reference to stability of operation.

Discussion, pp. 23-50, by Messrs. A. E. Kennelly, Alex Dow, E. W. Rice, Jr., Dugald C. Jackson, C. M. Green, John B. Taylor, H. G. Stott, Elihu Thomson, E. A. Sperry, and Charles P. Steinmetz.

Early experiences with arc lighting systems. Broad definition and examples of various kinds of electrical and mechanical instability. Permanent and transient volt-ampere characteristics of arcs.

THE APPLICATION OF STORAGE BATTERIES TO THE REGULATION OF THE ALTERNATING-CURRENT LOAD AT THE PLANT OF THE INDIANA STEEL COMPANY, GARY, INDIANA

J. Lester Woodbridge — Vol. xxviii—1909, pp. 851-866

Description, theory and results of batteries used in connection with

split-pole converters and synchronous exciters for regulation of alternating-current circuits.

Discussion, pp. 867-868, by Messrs. Edward Van Wagenen and J. L. Woodbridge.

Characteristics of synchronous exciter.

SOME PHASES OF TRANSFORMER REGULATION

W. A. Hillebrand and S. B. Charters, Jr. Vol. xxviii--1909, pp. 1253-1267

Experimental study of effect of phase and voltage unbalance on transformer regulation, using different systems of connection.

Discussion, pp. 1268-1278, by Messrs. F. E. Giebel, W. F. Lamme, B. G. Lamme, J. W. White, S. G. Gassaway, C. L. Cory, F. V. T. Lee, H. C. Holberton, and W. A. Hillebrand.

General discussion of the effects of voltage unbalance on power apparatus and measuring instruments connected to transformers.

DETERMINATION OF TRANSFORMER REGULATION UNDER LOAD CONDITIONS AND SOME RESULTING INVESTIGATIONS

Adolph Shane Vol. xxix—1910, pp. 1281-1294

Description of a method of measuring directly transformer regulation, also a method of direct determination of the transformer impedance triangle. Full account of tests made to establish the accuracy of the methods.

Discussion, pp. 1295-1302, by Messrs. Charles Fortescue, E. A. Wagner, L. T. Robinson, Ralph W. Atkinson, and Adolph Shane.

Objections to the author's methods. Modifications of the author's methods.

C. SWITCHING

THE CONTROL OF HIGH POTENTIAL SYSTEMS OF LARGE POWER

E. W. Rice, Jr. Vol. xviii—1901, pp. 407-420

Description of the type H oil switches designed for Metropolitan Traction Company and Manhattan Railway Company plants, together with short account of performance of oil, air and expulsion tube type switches under tests at high tension. General discussion of principles which should govern the layout of a central station.

Discussion (including that of paper by William S. Aldrich and George W. Redfield on "Performance of an Artificial Forty-Mile Transmission Line;" paper by F. A. C. Perrine on "Elements of Design, Particularly Pertaining to Long Distance Transmission;" paper by Charles F. Scott on "The Induction Motor and the Rotary Converter, and Their Relation to the Transmission System," and paper by Charles P. Steinmetz on "Theoretical Investigation of Some Oscillations of Extremely High Potential in Alternating-Current High Potential Transmissions"), pp. 421-442, and 667-669, by Messrs. Gano S. Dunn, George D. Shepardson, Henry W. Fisher, W. L. R. Emmett, A. E. Kennelly, Charles P. Stein-

metz, F. A. C. Perrine, L. B. Stillwell, Oberlin Smith, R. D. Mershon, Paul Janet, W. S. Aldrich, C. F. Scott, and Percy H. Thomas.

Relative advantages and comparative performance of induction motors and synchronous motors. Atmospheric losses at high tension lines as affected by diameter and stranding of conductor. Equation of rise of potential due to opening a circuit.

REVERSE-CURRENT CIRCUIT-BREAKERS AND THE PROTECTION OF TRANSMISSION LINES

Leonard Wilson **Vol. xxii—1903, pp. 303-309**

General characteristics and principles of operation of reverse-power relays. Description of Andrews reverse-power indicator and differential choke coils for preventing the establishment of a reverse power.

Discussion, pp. 310-311, by Messrs. H. G. Stott, Leonard Wilson, and Charles F. Scott.

Method of using differential choke coils on any number of parallel feeders.

THE USE OF AUTOMATIC MEANS FOR DISCONNECTING DISABLED APPARATUS

H. G. Stott **Vol. xxii—1903, pp. 427-430**

General recommendation for the protection of generators, transmission lines, synchronous converters and feeders, with reverse power and overload relays with and without time and current limit attachments.

Discussion (including that of paper by Henry W. Fisher on "Electric Cables for High Voltage Service" and paper by Philip Torchio on "The Operation and Maintenance of High-Tension Underground Systems"), pp. 431-444, by Messrs. W. F. Wells, Edward P. Burch, Carl Schwartz, W. G. Carlton, W. C. L. Eglin, C. O. Mailloux, Ralph D. Mershon, H. G. Stott, H. W. Fisher, W. L. Waters, R. S. Kelsch, and F. A. C. Perrine.

Experience in the operation of various large high-tension cable systems. General remarks on protection of transmission and distribution plants.

THE USE OF GROUP-SWITCHES IN LARGE POWER PLANTS

L. B. Stillwell **Vol. xxiii—1904, pp. 199-202**

Wiring layout of Manhattan Railway power plant. Illustrating use of group switches, followed by classified advantages and disadvantages of group switches in this particular instance.

Discussion, pp. 204-214 and 238-242 and 247-249, by Messrs. Alex Dow, Ralph D. Mershon, H. G. Stott, Lewis B. Stillwell, William B. Jackson, Gilbert Wright, John B. Taylor, H. F. Parshall, W. G. Carlton, P. Junkersfeld, W. A. Blanck, G. N. Eastman, James Lyman, and B. P. Rowe.

General remarks pro and con the use of group switches. Various methods of connecting generators to feeders advocated. Method of clearing short circuit on long lines where power plants are operated in parallel.

OIL SWITCHES FOR HIGH PRESSURES

E. M. Hewlett Vol. xxiii—1904, pp. 215-216

Comparison of oil-break with air-break switches.

Discussion, pp. 217-224, and 242-245 and 249-251, by Messrs. C. C. Chesney, F. A. C. Perrine, Alex Dow, Ralph D. Mershon, C. F. Scott, P. N. Nunn, C. L. de Muralt, H. F. Parshall, W. W. Blanck, James Lyman, P. Junkersfeld, W. G. Carlton, E. O. Sessions, G. N. Eastman, I. E. Brooke, P. H. Thomas, R. F. Schuchardt, Edw. Schildhauer, H. F. Sanville, and W. C. L. Eglin.

Experience with oil switches in many large plants. Accounts of tests under short-circuit conditions. Specifications for oil switches and brief reference to some of the mechanical difficulties encountered with present types.

TIME-LIMIT RELAYS

George F. Chellis Vol. xxiv—1905, pp. 247-259

Classification of time-limit relays. Ideal requirements of relays for the protection of alternating-current generators, feeders and synchronous converters. Characteristic performance curves of relays under various conditions. Wiring diagrams for relay connections.

Discussion, incorporated with paper by H. W. Buck on "Duplication of Electrical Apparatus to Secure Reliability of Service."

SWITCHBOARD PRACTICE FOR VOLTAGES OF 60,000 AND UPWARDS

Stephen Q. Hayes Vol. xxvi—1907, pp. 1333-1357

Brief general discussion of factors which enter into the choice and arrangement of control apparatus in high-tension plants, with special reference to oil switches and circuit breakers. Designs for 60,000 and 100,000-volt stations given to demonstrate the relative space required.

Discussion, pp. 1358-1362, by Messrs. P. M. Lincoln, F. B. H. Paine, D. B. Rushmore, H. W. Buck, J. B. Taylor, William McClellan, W. N. Smith, L. C. Nicholson, S. Q. Hayes, J. H. Finney, F. G. Baum, and Ralph D. Mershon.

Use of extra line wire for emergency service. Method of tying conductors to pin type insulators.

THE MODERN OIL SWITCH WITH SPECIAL REFERENCE TO SYSTEMS OF MODERATE VOLTAGE AND LARGE AMPERE CAPACITY

A. R. Cheney Vol. xxix—1910, pp. 1091-1108

Analytical discussion of the present status of oil switch construction, pointing out lines along which future progress is apt to take place. Record of performance of 90 oil switches in actual service.

Discussion, pp. 1109-1124, by Messrs. Peter Junkersfeld, Ford W. Harris, C. W. Stone, D. B. Rushmore, C. P. Steinmetz, W. I. Donshea, V. Karapetoff, G. F. Sever, A. R. Cheyney, and E. M. Hewlett.

General remarks on design and operation of oil switches. Experience in operation and results of experimental study.

17. TRACTION

A. RAILWAY SYSTEMS

NOTES ON MODERN ELECTRIC RAILWAY PRACTICE

Albert H. Armstrong Vol. xviii—1901, pp. 589-601

Consideration of the requirements of different classes of electric railway service leading up to a discussion of the relative merits of direct-current series and induction motors for interurban and trunk line operation.

Discussion, incorporated with that of paper by Ernst J. Berg on "Electric Railway Apparatus."

ELECTRIC RAILWAY APPARATUS

Ernst. J. Berg Vol. xviii—1901, pp. 603-630

Discussion of the characteristics and limitations of generators, converters, motor-generators and motors for different kinds of electric railway service. Extended consideration of the relative merits of direct-current series, and polyphase induction motors in a given numerical instance, comparing performance, efficiency and cost.

Discussion (including that of paper by Albert H. Armstrong on "Notes on Modern Electric Railway Practice"), pp. 631-666, by Paul Janet, Charles P. Steinmetz, G. Gillon, Charles Janisch, Bion J. Arnold, C. O. Mailloux, E. P. Roberts, L. B. Stillwell, A. H. Pott, C. F. Scott, P. K. Stern, H. C. Spaulding, F. S. Holmes, Ernst J. Berg, A. H. Armstrong, and N. C. Sawers.

General remarks on the stability of the induction motor for traction purposes.

SOME NOTES ON EUROPEAN PRACTICE IN ELECTRIC TRACTION WITH THREE-PHASE ALTERNATING CURRENTS

Carl L. DeMuralt Vol. xix—1902, pp. 499-526

Development of polyphase traction system in Europe, with brief descriptions of the various roads that have been equipped with this system, and results of various tests showing the performance curves of the motors under actual service conditions.

Discussion, incorporated with that of paper by Ernst Danielson on "A Novel Combination of Polyphase Motors for Traction Purposes."

A NOVEL COMBINATION OF POLY-PHASE MOTORS FOR TRACTION PURPOSES

Ernst Danielson Vol. xix—1902, pp. 527-539

Description of a system of concatenating two motors of unequal numbers of poles so as to get four running speeds. Comparison of acceleration characteristics, torque, energy, efficiency, etc., with direct-current series, plain induction and concatenated induction motors. Abstracted by Dr. Charles P. Steinmetz on page 495.

Discussion (including that of paper by Carl L. DeMuralt on "Some Notes on European Practice in Electric Traction With Three-Phase Alternating-Current"), pp. 540-555, by Messrs. C. P. Steinmetz, C. O. Mailloux, Henry G. Stott, W. N. Smith, W. J. Hammer, Townsend Wolcott, Frederick V. Henshaw, and C. L. DeMuralt.

NEW ELECTRO-PNEUMATIC SYSTEM OF ELECTRIC RAILWAY CONSTRUCTION

Bion J. Arnold — Vol. xix—1902, pp. 1003-1006

Announcement of the system and outline of its advantages.

Discussion (including that of paper by A. H. Armstrong on "A Study of the Heating of Railway Motors;" paper by B. J. Arnold and W. B. Potter on "Comparative Acceleration Tests With Steam Locomotive and Electric Motor Cars;" paper by B. J. Arnold on "Method of Accelerating by Means of a Dynanometer Car, the Power Required to Operate the Trains of the New York Central and Hudson River Railroad Company Between Mott Haven Junction and the Grand Central Station, and the Relative Cost of Operation by Steam and Electricity;" and paper by C. O. Mailloux on "Notes on the Plotting of Speed-Time Curves"), pp. 1007-1019, by Messrs. F. J. Sprague, F. S. Pearson, Oberlin Smith, S. T. Dodd, C. P. Steinmetz, H. Ward-Leonard, Harry Alexander, A. H. Armstrong, W. B. Potter, B. J. Arnold, and C. O. Mailloux. General remarks on the applications of electric motive power to steam railroads.

WASHINGTON, BALTIMORE & ANNAPOLIS SINGLE-PHASE RAILWAY

B. G. Lamme — Vol. xx—1902, pp. 15-30

Announcement of the first single-phase railway in the United States, with general description of the plant and discussion of the advantages of this system over the direct-current system.

Discussion, pp. 31-49, by Messrs. Charles P. Steinmetz, Ralph D. Mershon, W. E. Goldsborough, Bion J. Arnold, W. S. Franklin, Norman Rowe, C. O. Mailloux, Joseph Sachs, W. M. C. Gotshall, Herbert A. Wagner, Elias E. Ries, B. G. Lamme, P. K. Stern, C. F. Scott, and N. W. Storer.

Opinions as to the principal feature of the single-phase railway motor. Repulsion *vs.* series alternating-current motors.

MULTIPLE UNIT, VOLTAGE SPEED CONTROL FOR TRUNK LINE SERVICE

H. Ward Leonard — Vol. xx—1902, pp. 155-158

Enumeration of the essential features and advantages of the author's method of operating electric locomotives from single-phase distribution system.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous-Current Motors for Machine Tools."

THE ALTERNATING-CURRENT RAILWAY MOTOR

Charles P. Steinmetz Vol. xxiii—1904, pp. 9-25

Brief account of early work with compensated series commutator single-phase motor. Design data given for motors built by Eickemeyer and actual performance characteristics of this motor compared with calculated performance of repulsion motor. Analytical theory of single-phase repulsion motor.

Discussion (including that of paper by Walter I. Slichter on "Speed-Torque Characteristics of the Single-Phase Repulsion Motor"), pp. 26-81, by Messrs. B. G. Lamme, A. S. McAllister, B. J. Arnold, Charles P. Steinmetz, P. M. Lincoln, W. I. Slichter, Ralph D. Mershon, A. H. Armstrong, Robert Lundell, O. S. Lyford, Jr., H. A. Wagner, Charles F. Scott, B. A. Behrend, W. S. Franklin, Dugald C. Jackson, and V. Karapetoff.

Theory of operation of compensated series and repulsion motors treated analytically and graphically. Observed performance characteristics of repulsion motor as motor and as generator.

SINGLE-PHASE RAILWAYS

W. A. Blanck Vol. xxiii—1904, pp. 83-100

Brief mention of various types of motors that have been proposed for single-phase railways, followed by remarks on line construction for single-phase railways and detailed estimate of comparative cost of construction of 60-mile interurban road to operate respectively with direct-current and single-phase motor power.

No discussion.

EFFECT OF SELF-INDUCTION ON RAILWAY MOTOR COMMUTATION

E. H. Anderson Vol. xxiii—1904, pp. 379-391

Experimental study of commutation with oscillographic records of pressures between commutator segments under various conditions, and of potential rise in field and armature windings due to interruption and restoration of power at free running speeds.

Discussion (including that of paper by W. L. Waters on "Predetermination of Sparking in Direct-Current Machines"), pp. 443-457, by Messrs. W. L. Waters, E. R. Douglas, R. B. Treat, Thorburn Reid, E. H. Anderson, W. S. Franklin, Clarence P. Feldman, and H. Ward Leonard.

General remarks on commutation reaction and predetermination of the limitation of commutation.

PRESIDENT'S ADDRESS

Bion J. Arnold Vol. xxiii—1904, pp. 615-623

Brief sketch of electric railway development since 1893. Present prospects of electric locomotives supplanting steam locomotive. Dividing line between steam and electric trunk line operation.

Discussion, pp. 624-644, by Messrs. Charles P. Steinmetz, John Perry,

B. G. Lamme, C. V. Drysdale, B. J. Arnold, F. J. Sprague, and Elihu Thomson.

The requirements of different classes of railway service—city, suburban and interurban, passenger trunk line, freight trunk line, and mountain service. Speed-torque characteristics of various types of railway motors, single-phase, polyphase and direct-current, and discussion of proper spheres of application of the various motors. Development and application of single-phase compensated series motor. Methods of control. Invention of the repulsion motor.

PROBLEMS OF HEAVY ELECTRIC TRACTION

O. S. Lyford, Jr. and W. N. Smith Vol. xxiii—1904, pp. 691-722

Review of the considerations which enter into the problem of selecting the electric equipment for the Long Island Railroad. Account of tests made to check accuracy of train resistance formulas. Also tests with steam and electric trains.

Discussion, pp. 723-757, by Messrs. L. B. Stillwell, C. O. Mailloux, H. Ward Leonard, W. S. Franklin, A. H. Armstrong, C. T. Hutchinson, W. N. Smith, E. E. Ries, O. S. Lyford, Jr., and William McClellan.

General discussion of train resistance formulas, speed-time curves and the other factors which enter into the selection of motor equipment for trunk line operation. Comparison between speed-time and power-time curves for constant current per motor and constant current per car.

THREE-PHASE TRACTION

F. N. Waterman Vol. xxiv—1905, pp. 465-509

Calculated performance of three-phase system with air gap and frequency of Valtellina line and other conditions the same as assumed by Mr. Berg in paper Vol. XVIII., 1901, page 603. Results compared with Mr. Berg's results for direct-current and three-phase systems with standard direct-current air-gap. Results of performance tests with Valtellina line. Comparison of dimensions and efficiencies of New York Central and Valtellina locomotive. Discussion of the inherent advantage of the three-phase system.

Discussion, pp. 510-523, by Messrs. F. N. Waterman, W. N. Smith, Charles P. Steinmetz, C. O. Mailloux, S. M. Kintner, H. G. Stott, and C. L. DeMuralt.

Disadvantages and advantages of the three-phase system of electric traction.

HEAVY TRACTION PROBLEMS IN ELECTRICAL ENGINEERING

Carl L. DeMuralt Vol. xxiv—1905, pp. 525-552

Theoretical study of the comparative merits of three-phase and direct-current systems for heavy trunk line railroad service under definite assumed conditions, with tabulated results of all calculations.

Discussion, pp. 553-560, by Messrs. C. O. Mailloux, S. T. Dodd, F. N. Waterman, Charles P. Steinmetz, and C. L. DeMuralt.

General remarks on the performance characteristics of three-phase railway motor, with special reference to acceleration and recuperation of energy.

WEIGHT DISTRIBUTION ON ELECTRIC LOCOMOTIVES AS AFFECTED BY MOTOR SUSPENSION AND DRAW-BAR PULL

S. T. Dodd **Vol. xxiv—1905, pp. 591-607**

Theoretical investigation of the weight distribution factor in various types of locomotive trucks, showing the effect of motor suspension, swivel trucks, pony trucks, etc., in the determination of tractive effort. Results of numerical examples given in tables.

Discussion, pp. 608-609, by Messrs. C. O. Mailloux, F. N. Waterman, and S. T. Dodd.

LIGHT ELECTRIC RAILWAYS

James R. Cravath **Vol. xxiv—1905, pp. 1067-1077**

Description of a narrow gauge single-phase railway with light track construction suggested for rural transportation. Estimated first cost, operating expenses and gross earnings from freight and passenger traffic for location in central states.

No discussion.

ON THE SUBSTITUTION OF THE ELECTRIC MOTOR FOR THE STEAM LOCOMOTIVE

Lewis B. Stillwell and Henry St. Clair Putnam **Vol. xxvi—1907, pp. 31-101**

Elaborate analysis of available data on actual cost of operation and maintenance of steam and electric railways. Estimated cost and saving incident to the electrification of all the steam roads in the United States with 11,000-volt single-phase system. Estimated power and energy consumption for average passenger and freight service on railroads of the United States. Importance of standardizing location of working conductor and frequency in electric railroad systems.

Discussion, pp. 102-161, by Messrs. Frank J. Sprague, B. G. Lamme, Bion J. Arnold, W. B. Potter, W. S. Murray, O. S. Lyford, Jr., C. L. DeMuralt, A. H. Armstrong, N. W. Storer, William McClellan, W. I. Slichter, J. B. Whitehead, L. B. Stillwell, Calvert Townley, Ralph D. Mershon, H. M. Brinckerhoff, A. H. Babcock, and Clarence Renshaw.

Lively discussion of the relative advantages of the direct-current, single-phase and three-phase systems for operation of railroads, with performance characteristics and operative data from different actual installations. Observed cost of fuel and steam locomotive repairs on the N. Y., N. H. & H. R. R. Numerous opinions as to best frequency for single-phase railway system.

THE SINGLE-PHASE COMMUTATOR TYPE MOTOR

B. G. Lamme — Vol. xxvii—1907, pp. 137-156

Brief discussion of certain features in the design of compensated single-phase series motors for railway service; covering effects of magnetic induction and frequency in commutation and torque; decrease of effective air gap; effect of power-factor on overload torque, etc.

No discussion.

HIGH-VOLTAGE DIRECT-CURRENT AND ALTERNATING-CURRENT SYSTEMS FOR INTERURBAN RAILWAYS

W. J. Davis, Jr. — Vol. xxvi—1907, pp. 387-392

Brief discussion of relative merits of 600-volt direct-current, 1,200-volt direct-current and 6,600-volt alternating-current systems for railway motor power, with estimated comparative first costs, operative costs, economy and other technical data.

Discussion, pp. 393-400, by Messrs. James Lyman, Mr. Hesing, Mr. Gould, W. J. Davis, Jr., Peter Junkersfeld, W. A. Blanck, T. F. Clohesey, L. M. Zapp, I. E. Brooke, H. R. King, Mr. Hatch, and E. N. Lake.

Additional information on the single-phase and 1,200-volt system.

SOME FACTS AND PROBLEMS BEARING ON ELECTRIC TRUNK LINE OPERATION

Frank J. Sprague — Vol. xxvi—1907, pp. 681-772

General discussion of the problem of heavy railroad electrification, dwelling especially on the relative advantages of the direct-current and single-phase railway system. Comparison of different types of motors on basis of equal weights. Relative merits of various types of overhead and third-rail construction of direct-current, single-phase and three-phase motors, and of different types of locomotive running gears. Brief description of New York Central and New Haven locomotives. List of articles by author on subject of electric railways.

Discussion, pp. 773-812, by Messrs. W. J. Wilgus, Lewis B. Stillwell, W. B. Potter, Charles F. Scott, N. W. Storer, G. R. Henderson, William McClellan, A. H. Armstrong, C. P. Steinmetz, Frank J. Sprague, W. S. Murray, and T. J. Johnson.

Heated discussion of the relative merits of direct-current and single-phase methods of electric traction. Data on the comparative cost of the two systems.

THE CHOICE OF FREQUENCY FOR SINGLE-PHASE ALTERNATING-CURRENT RAILWAY MOTORS

A. H. Armstrong — Vol. xxvi—1907, pp. 1377-1383

Brief general discussion of relative merits of 25 and 15 cycles in single-phase railway work, as regards motor equipment, coefficient of adhesion, generating and distributing apparatus.

Discussion, incorporated with paper by N. W. Storer on "Twenty-five *versus* Fifteen Cycles for Heavy Railways."

TWENTY-FIVE VERSUS FIFTEEN CYCLES FOR HEAVY RAILWAYS

N. W. Storer Vol. xxvi—1907, pp. 1385-1393

Brief general discussion of the relative advantages of 25 and 15 cycles in single-phase railway operation, with special reference to the effects on locomotive design and performance characteristics.

Discussion (including that of paper by A. H. Armstrong on "The Choice of Frequency for Single-phase Alternating-Current Railway Motors"), pp. 1394-1406, by Messrs. H. G. Reist, C. W. Stone, E. J. Berg, L. B. Stillwell, W. N. Smith, William McClellan, Charles P. Steinmetz, Peter Junkersfeld, Gano S. Dunn, Henry G. Stott, A. H. Armstrong, and N. W. Storer.

General remarks on the choice of frequency for single-phase railways. Most economical frequency for different apparatus employed in the system. Power required to handle steam railroad traffic entering Chicago.

COMMUTATING-POLE DIRECT-CURRENT RAILWAY MOTORS

E. H. Anderson Vol. xxvi—1907, pp. 1407-1417

Brief review of troubles encountered in the design of railway motors, leading up to commutation which is treated more in detail. Theory of action of commutating poles in series motor and possibilities as to voltage and service capacity which it introduces into direct-current railway engineering.

Discussion, pp. 1418-1419, by Messrs. Gano Dunn, J. C. Lincoln, E. H. Anderson, and W. N. Smith.

Flashing and creeping distances on 600-volt ordinary and 1,200-volt commutating pole railway motors.

REGENERATION OF POWER WITH SINGLE-PHASE ELECTRIC RAILWAY MOTORS

William Cooper Vol. xxvi—1907, pp. 1469-1480

General requirements and motor characteristics necessary for successful regenerative control. Theory of regenerative control of single-phase series motors with examples of its practical applications.

Discussion, pp. 1481-1484, by Messrs. W. I. Slichter, L. B. Stillwell, J. C. Lincoln, and William Cooper.

Compounding effect utilized to improve power factor of returned energy. Advantages of regenerative control.

PRACTICAL ASPECTS OF STEAM RAILROAD ELECTRIFICATION

W. N. Smith Vol. xxvi—1907, pp. 1693-1708

General discussion of steam railroad electrification from the standpoint of the steam railroad engineer and operator.

No discussion.

A SINGLE-PHASE RAILWAY MOTOR

E. F. Alexanderson Vol. xxvii—1908, pp. 1-17

Classification of single-phase railway motors, followed by theoretical analysis of the performance characteristics of series-repulsion motor.

Discussion, pp. 18-42, by Messrs. L. B. Stillwell, B. G. Lamme, W. B. Potter, O. S. Lyford, Jr., W. I. Slichter, S. N. Kintner, Charles P. Steinmetz, W. S. Murray, E. F. Alexanderson, and Elmer A. Sperry.

General remarks on the relative merits of series-repulsion and compensated series motors, with considerable data on the actual performance of the compensated series motor as to power-factor, commutation, brush wear, etc.

FROM STEAM TO ELECTRICITY ON A SINGLE-TRACK RAILROAD

J. B. Whitehead — Vol. xxvii—1908, pp. 1139-1168

Analytical study of the relative merits of 6,600-volt single-phase, and 600-volt direct-current system for a certain single-track railway line—covering calculation of impedance of distribution system; construction of speed, current and power-time curves, cost of construction, maintenance and operation. Actual cost of steam operation.

Discussion, pp. 1169-1175, by Messrs. J. B. Whitehead, W. I. Slichter, William McClellan, A. H. Babcock, A. W. Copley, Charles F. Scott, and S. H. Clarkson.

Results of actual tests on the constants of alternating-current railway circuits—impedance, resistance and reactance for trolley and rails on four, two and one-track roads.

THE LOG OF THE NEW HAVEN ELECTRIFICATION

W. S. Murray — Vol. xxvii—1908, pp. 1613-1664

Detailed account of the troubles encountered in the first four months' operation of the electric zone of the New Haven road, covering power plant (three-phase turbo-generators load on one phase) distribution system and locomotives. Complete tabular and graphical logs of delays, repairs, locomotive performance, etc., supplemented by measures to overcome the various difficulties encountered.

Discussion, pp. 1665-1719, by Messrs. L. A. Ferguson, Calvert Townley, B. G. Lamme, L. B. Stillwell, E. B. Katte, H. P. Davis, Charles P. Steinmetz, Philip Torchio, Minor M. Davis, B. A. Behrend, H. F. Parshall, A. H. Armstrong, N. W. Storer, O. S. Lyford, Jr., W. N. Smith, Philip Dawson, Ivan Ofverholm, C. E. Eveleth, and W. S. Murray.

Additional information on the performance of the New Haven single-phase locomotives, the generators and the improved circuit breaking apparatus. Comparison of the New Haven single-phase locomotive and the New York Central direct-current locomotive. Operation experience with the single-phase line of the Erie Railroad. Overhead catenary construction of the London, Brighton and South Coast Railway.

ELECTRIC SYSTEM OF GREAT NORTHERN RAILWAY COMPANY AT CASCADE TUNNEL

Cary T. Hutchinson — Vol. xxviii—1909, pp. 1281-1319

Description of design, construction and operation of electrical equipment, with brief statement of the economies effected. Frictional resist-

ance of steam locomotives and tests of regenerative control of induction motors.

Discussion, pp. 1320-1359, by Messrs. L. B. Stillwell, Cary T. Hutchinson, W. S. Murray, E. B. Katte, Bion J. Arnold, F. N. Waterman, J. H. Davis, L. R. Pomeroy, W. N. Smith, F. S. Denneen, W. I. Slichter, E. F. W. Alexanderson, C. L. DeMuralt, Calvert Townley, Charles P. Steinmetz, Carl Schwartz, Frank J. Sprague, Edward P. Burch, Max Toltz, and E. Marshall.

General discussion of the relative merits of different systems of heavy electric traction, also of the economy and other advantages of electric over steam motive power. Additional description of the Great Northern system covering the overhead construction and the motor control and some of the difficulties in motor design.

THE 1,200-VOLT RAILROAD—A STUDY OF ITS VALUE FOR INTERURBAN RAILWAYS

Charles E. Eveleth **Vol. xxix—1910, pp. 1-14**

Detailed estimate of the cost of construction, operation and maintenance of 1,200 and 600-volt direct-current interurban railways, based on four concrete applications.

Discussion, pp. 15-22, by Messrs. W. S. Murray, L. B. Stillwell, and C. E. Eveleth.

General remarks on the choice of system for interurban and other railroad lines.

ON THE SPACE ECONOMY OF THE SINGLE-PHASE SERIES MOTOR

William S. Franklin and Stanley S. Seyfert **Vol. xxix—1910, pp. 23-40**

Theory and tests of a balanced choke coil arrangement for preventing excessive short-circuit currents due to pulsating flux; also description of a proposed single-phase commutator motor with external armature and commutator, intended to give improved utilization of space.

Discussion, pp. 41-53, by Messrs. S. M. Kintner, E. H. Anderson, E. F. W. Alexanderson, S. S. Seyfert, L. B. Stillwell, and W. S. Franklin.

Detailed criticism of the external armature type motor tending to show its impracticability. Brief mention of other methods of improving space economy. Weight and space factors from actual practice.

THE DESIGN OF THE ELECTRIC LOCOMOTIVE

N. W. Storer and G. M. Eaton **Vol. xxix—1910, pp. 1415-1439**

General discussion of some of the mechanical features in the design of electric locomotives, with special reference to the mode of mounting the motors and of coupling them to the driving wheels. Requirements of different classes of railroad service. Relation of height of center of gravity to lateral track disturbances.

Discussion, pp. 1440-1459, by Messrs. William McClellan, A. F. Batch-

elder, Frank J. Sprague, A. H. Armstrong, G. M. Eaton, N. W. Storer, and Elmer A. Sperry.

General remarks on the design of running gear for electric locomotives, with expression of opinion on the effect of height of center of gravity on the track. Tests on separately driven and coupled drivers.

B. TRAIN MOVEMENT AND MOTOR CAPACITY

THE RELATION OF ENERGY AND MOTOR CAPACITY TO SCHEDULE SPEED IN THE MOVING OF TRAINS BY ELECTRICITY

Cary T. Hutchinson **Vol. xix—1902, pp. 129-164**

Analytical and graphical investigation of ideal speed-time curves, showing the effect of varying acceleration on size of motor, energy consumption and total economy of operation. Methods of calculation fully explained by use of numerical examples.

Discussion, incorporated with that of paper by W. B. Potter on "The Selection of Electric Motors for Railway Service."

A CONSIDERATION OF THE INERTIA OF THE ROTATING PARTS OF A TRAIN

Norman Wilson Storer **Vol. xix—1902, pp. 165-168**

The equivalent inertia, weight of wheels and motors—its magnitude; effect of change of gear ratio and simple methods of including it in train performance calculations.

Discussion, incorporated with that of paper by W. B. Potter on "The Selection of Electric Motors for Railway Service."

THE SELECTION OF ELECTRIC MOTORS FOR RAILWAY SERVICE

W. B. Potter **Vol. xix—1902, pp. 169-177**

Discussion of the various factors which enter into the determination of the size of motor required for a given service—gear ratio, losses and their distribution, etc. Table based on service tests showing the schedule speeds for different gear ratios, stops per mile and tons per motor for a given motor.

Discussion (including that of paper by Cary T. Hutchinson on "The Relation of Energy and Motor Capacity to Schedule Speed in Moving of Trains by Electricity;" and paper by Norman Wilson Storer on "A Consideration of the Inertia of the Rotating Parts of a Train"), pp. 178-182, by Messrs. W. C. Gotshall, M. H. Gerry, Jr., Philip Torchio, H. G. Stott, Charles P. Steinmetz, S. T. Dodd, P. O. Keilholtz, Louis Duncan, and Cary T. Hutchinson. Sharp criticisms of Dr. Hutchinson's paper. Detailed criticisms of Dr. Hutchinson's assumptions and conclusions by comparison with calculations made for the New York & Portchester Railroad. Use of Dr. Hutchinson's formulas in definite problem, comparing results with those obtained by usual methods.

A STUDY OF THE HEATING OF RAILWAY MOTORS

A H. Armstrong Vol. xix—1902, pp. 809-832

Outline of method of determining probable heating and energy consumption of given equipment for any class of work based on actual experiments.

Discussion, incorporated with that of paper by Bion J. Arnold on "New Electro-Pneumatic System of Electric Railway Construction."

COMPARATIVE ACCELERATION TESTS WITH STEAM LOCOMOTIVE, AND ELECTRIC MOTOR CARS

B. J. Arnold and W. B. Potter Vol. xix—1902, pp. 833-850

Description and average results of tests carried out by the authors in preparing report on the use of electricity for the propulsion of trains of the New York Central Railroad. Comparative performance of steam and electric engines under frequent-stop suburban service, with results of tests plotted as curves and arranged in tables giving the energy and power consumption, maximum acceleration utilization of weight on drivers, energy efficiency, coal consumption, etc.

Discussion, incorporated with that of paper by B. J. Arnold on "New Electro-Pneumatic System of Electric Railway Construction."

METHOD OF ASCERTAINING BY MEANS OF A DYNANOMETER CAR THE POWER REQUIRED TO OPERATE THE TRAINS OF THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD BETWEEN MOTT HAVEN JUNCTION AND GRAND CENTRAL STATION, AND THE RELATIVE COST OF OPERATION BY STEAM AND ELECTRICITY

Bion J. Arnold Vol. xix—1902, pp. 865-899

Description of the dynanometer car and its mode of operation. Curve records of tests. Tabulated results and discussion of the method of working up the data. Comparative fixed and operating costs for steam and electric motive power.

Discussion, incorporated with that of B. J. Arnold on "New Electro-Pneumatic System of Electric Railway Construction."

NOTES ON THE PLOTTING OF SPEED-TIME CURVES

C. O. Mailloux Vol. xix—1902, pp. 901-1001

Detailed analytical study of methods of calculating and plotting speed-time curves for determining motor capacity required for a given service. Accurate graphical method proposed. Charts of coefficients for use in plotting speed-time curves. Numerical examples of the calculation and plotting of speed-time, and distance-time curves for service runs. All formulas developed and rigorously proved.

Discussion, incorporated with that of paper by B. J. Arnold on "New Electro-Pneumatic System of Electric Railway Construction."

BRAKING AND TRACTION BRAKES

Vol. xx—1902, pp. 215-217

Introduction by President Charles F. Scott.

SOME BRAKE TESTS AND DEDUCTIONS THEREFROM

J. D. Keiley Vol. xx—1902, pp. 219-233

A description of a method of making brake tests and of a manual recording apparatus used in this method; also results from tests on a number of varieties of brakes and an empirical equation showing the operation of these brakes under different conditions, the coefficients entering into the equation being derived from the tests.

RAILROAD CAR BRAKING

R. A. Parke Vol. xx—1902, pp. 235-275

Brief sketch of development of power brakes. Analysis of Westinghouse-Galton braking tests, giving equations for the coefficients of friction under various conditions. Outline of the requirements and limitations of high-speed braking. Analytical study of the distribution of forces in car brakes acted on by retarding force, showing loss of efficacy occasioned by re-distribution of weight, followed by description of a method of brake rigging construction to compensate this loss. Equations for determining maximum braking force under various conditions. Description of construction and mode of operation of the magnetic traction brake.

Discussion, pp. 276-300, by Messrs. H. G. Stott, C. O. Mailloux, O. S. Lyford, Jr., Calvert Townley, W. O. Gotshall, R. A. Parke, Elias E. Ries, W. N. Smith, W. J. Hammer, W. S. Franklin, William Esty, H. H. Westinghouse, F. C. Newell, N. W. Storer, Calvin W. Rice, Charles F. Scott B. J. Arnold, T. P. Gaylord, J. R. Cravath, R. H. Pierce, and Eugene B. Clark.

General remarks on high-speed power braking and the possibilities of predetermining braking performance. General results of actual tests. Characteristics and performance of the magnetic traction brake. Historical notes on magnetic, eddy-current and hysteresis brakes.

HIGH-SPEED ELECTRIC RAILWAY PROBLEMS

A. H. Armstrong Vol. xxii—1903, pp. 91-108

Development of graphical charts for calculation of interurban motive power problems—relations between schedule speeds, maximum speed and stops per mile; between motor rating, schedule speed and tons per mile; schedule speed and average consumption. Numerical example showing the relative cost and economy of one-car and two-car operation, solved by use of the charts.

No discussion.

PREDETERMINATION IN RAILWAY WORK

F. W. Carter Vol. xxii—1903, pp. 133-164

Development of a system of simple equations which permit the rapid calculation of train performance and the determination of motor capacity for a given service. Charts given for facilitating calculations of speed-

time, speed-distance and time-distance curves. Numerical examples illustrating the use of charts and formulas.

Discussion, pp. 165-174, by Mr. C. O. Mailloux.

Comparison of Mailloux's method with that of the author. Development of general equations for solution of train movement problems.

INTERURBAN CAR TESTS

W. E. Goldsborough and P. E. Fansler Vol. xxii—1903, pp. 175-221

Description and results of tests on interurban lines of Indiana Union Traction Company's system, covering energy and power consumption for different kinds of service, and effect of personality of motorman thereon. Special service capacity tests on different types of equipment. Data presented in form of tables and formulas.

Discussion, pp. 222-230, by Messrs. E. P. Roberts and I. H. Sherwood, and A. H. Armstrong.

Description and results of tests of passenger car, limited car, express car and two-car train on lines of Northern Texas Traction Company; power and energy consumption.

SOME NOTES ON THE OPERATION OF RAILWAY MOTORS IN SERVICE

Clarence Renshaw Vol. xxii—1903, pp. 279-297

Consideration of factors which limit safe load on railway motors. Discussion of characteristics of service loads and losses and method of producing equivalent loads. Description of tests on city car in actual service with results plotted on graphic charts.

Discussion (including that of paper by W. E. Goldsborough and P. E. Fansler on "The Storage Battery in Sub-stations"), pp. 298-302, by Messrs. Cary T. Hutchinson, H. G. Stott, W. E. Goldsborough, and A. H. Armstrong.

Predetermination of temperature rise of railway motors by Hutchinson method. Value of storage battery in railway sub-stations. Arguments against square root of mean square current method of determinating motor capacity.

THE CONDITIONS GOVERNING THE RISE OF TEMPERATURE OF ELECTRIC RAILWAY MOTORS IN SERVICE

Cary T. Hutchinson Vol. xxii—1903, pp. 657-679

Development of a method of obtaining for a given schedule and for a given temperature rise, the size of the motor in horse-power per ton, the energy input and the critical acceleration for any motor, taking as data the I^2R and the core losses of the motor and radiation coefficients determined by actual tests under service conditions. Sets of curves for facilitating calculations and examples illustrating their use.

Discussion, pp. 680-687, by Messrs. A. H. Armstrong, Cary T. Hutchinson, and Louis Duncan.

Limitations imposed by author's assumptions. Demonstration of the accuracy of the method for general application.

PROBLEMS OF HEAVY ELECTRIC TRACTION

O. S. Lyford, Jr., and W. N. Smith **Vol. xxiii—1904 pp. 691-722**

Review of the considerations which entered into the problem of selecting the electric equipment for the Long Island Railroad. Account of tests made to check accuracy of train resistance formulas. Also tests with steam and electric trains.

Discussion, pp. 723-757, by Messrs. L. B. Stillwell, C. O. Mailloux, H. Ward Leonard, W. S. Franklin, A. H. Armstrong, C. T. Hutchinson, W. N. Smith, E. E. Ries, O. S. Lyford, Jr., and William McClellan.

General discussion of train resistance formulas, speed-time curves and the other factors which enter into the selection of motor equipment for trunk line operation. Comparison between speed-time and power-time curves for constant current per motor and constant current per car.

TWO-MOTOR VERSUS FOUR-MOTOR EQUIPMENTS

N. McD. Crawford **Vol. xxiv—1905, pp. 65-75**

Tests with four cars under equal conditions in city service, giving energy consumption per ton mile and per passenger and other operation data.

Discussion, pp. 76-80, by Messrs. N. McD. Crawford, A. H. Armstrong, S. T. Dodd, and Calvert Townley.

General remarks on four-motor versus two-motor car equipments.

CHOICE OF MOTORS IN STEAM AND ELECTRIC PRACTICE

William McClellan **Vol. xxiv—1905, pp. 561-572**

Tabulated technical data on steam locomotives for local, express and freight service on principal roads in North America, giving type, dimensions, weights, fuel, tractive efforts, loads, road profile, etc. Discussion of characteristic features of steam and electric motive power and desirability of standardizing electric locomotives.

Discussion, pp. 573-576, by Messrs. W. E. Goldsborough, C. O. Mailloux, Charles P. Steinmetz, and H. G. Stott.

Practical difficulties of standardization.

INERURBAN TEST CAR OF THE UNIVERSITY OF ILLINOIS

Thomas M. Gardner **Vol. xxv—1906, pp. 507-517**

Description of the car and its equipment, with special reference to a method of measuring acceleration directly with a voltmeter.

Discussion, page 518, by Messrs. P. M. Lincoln, D. C. Jackson, and M. K. Akers.

COMPARATIVE PERFORMANCE OF STEAM AND ELECTRIC LOCOMOTIVES

Albert H. Armstrong **Vol. xxvi—1907, pp. 1643-1674**

General discussion of the relative merits of direct-current and alternating-current electric locomotives and simple and compound steam locomotives, with special reference to capacity and cost of operation. Performance characteristic curves for steam and electric machines. Results of

tests of actual fuel consumption of steam locomotives on mountain grades.

Discussion, pp. 1675-1691, by Messrs. William J. Wilgus, Cary T. Hutchinson, W. S. Murray, William McClellan, C. L. deMuralt, W. N. Smith, Charles P. Steinmetz, and A. H. Armstrong.

Actual savings and increase in capacity attained with New York Central terminal electrification. Comparison of Mallet compound with electric locomotive. Tests of fuel consumption of steam locomotives in express, local and freight traffic on New Haven road. Comparative cost of increasing number of tracks and electrification.

FROM STEAM TO ELECTRICITY ON A SINGLE-TRACK RAILROAD

J. B. Whitehead — Vol. xxvii—1908, pp. 1139-1168

Analytical study of the relative merits of 6,600-volt single-phase, and 600-volt direct-current system for a certain single-track railway line—covering calulation of impedance of distribution system; construction of speed, current and power-time curves, cost of construction, maintenance and operation. Actual cost of steam operation.

Discussion, pp. 1169-1175, by Messrs. J. B. Whitehead, W. I. Slichter, William McClellan, A. H. Babcock, A. W. Copley, Charles F. Scott, and S. H. Clarkson.

Results of actual tests on the constants of alternating-current railway circuits—impedance, resistance and reactance for trolley and rails on four, two and one-track roads.

POWER ECONOMY IN ELECTRIC RAILWAY OPERATION—COASTING TESTS ON THE MANHATTAN RAILWAY, NEW YORK

H. St. Clair Putnam — Vol. xxix—1910, pp. 1461-1485

Analytical study of the relations between coasting time and acceleration, braking and time of stop, showing how, for a given schedule, the coasting time constitutes a direct measure of the saving of energy, the calculated results being checked by tests made with a coasting clock. Record of actual operation with coasting clock on a large scale, showing its effect on the efficiency of the motorman.

Discussion, pp. 1486-1494, by Messrs. John B. Taylor, A. H. Armstrong, N. W. Storer, William McClellan, L. B. Stillwell, Frank J. Sprague, G. H. Hill, H. St. Clair Putnam, and P. A. Bancel.

General remarks on the methods of saving energy by using automatic acceleration or retardation, and examples showing saving due to use of grades into and out of stations.

A METHOD FOR DETERMINING THE ADEQUACY OF AN ELECTRIC RAILWAY SYSTEM

R. W. Harris — Vol. xxix—1910, pp. 1495-1516

Description of methods of determining the amount and quality of service furnished by a city street railway, with results of investigations in Milwaukee and other large cities, covering the movements and habits of people, headways, delays, time of stops, etc.

No discussion.

C. DISTRIBUTION CIRCUITS

SOME RECOMMENDATIONS CONCERNING ELECTRICAL AND MECHANICAL SPECIFICATIONS OF TROLLEY INSULATORS

Samuel Sheldon and John D. Keiley — Vol. xxii—1903, pp. 231-239

Description of methods and results of testing strain insulators for tensile strength, breakdown e. m. f., insulation resistance and determination of maximum working temperature for round top trolley suspension insulators. Specifications for various forms of insulators for overhead trolley construction.

Discussion, pp. 240-242, by Messrs. Joseph Sachs, Ralph D. Mershon, and Samuel Sheldon.

Recommendations for standard railway insulator specifications. A. c. *vs.* d. c. for testing insulators for use on d. c. circuits.

ON THE CALCULATION OF LINE BATTERIES

W. E. Winship — Vol. xxiii—1904, pp. 393-402

Outline of method of determining the size and location of battery floating on railway distribution system under various conditions of service.

Discussion, pp. 457-459, by Messrs. F. J. White, Lamar Lyndon, and W. E. Winship.

Practical importance of battery resistance in calculation of line batteries.

ON TRACK BONDING

C. W. Ricker — Vol. xxiv—1905, pp. 81-92

Classification of rail bonds. General remarks on inspection, failure and installation of bonds. Actual costs of installation and tests on the resistance of bonded joints after several years of service.

Discussion, pp. 93-96, by Messrs. C. W. Ricker, H. A. Lardner, A. A. Knudson, William Pestell, Calvert Townley, and Ralph D. Mershon.

Calculation of most economical cross section of bonds. General remarks on installation of bonds, their deterioration and the measurement of contact resistance.

LINE CONSTRUCTION FOR HIGH-PRESSURE ELECTRIC RAILROADS

George A. Damon — Vol. xxiv—1905, pp. 97-121

Description of high-tension overhead trolley construction in Europe and United States, illustrated by numerous detail drawings. Description of Huber system of current collection. General conclusions regarding standard trolley voltage, standard location of working condition and type of construction for high-voltage work on interurban and trunk lines.

Discussion, incorporated with paper by Theodore Varney on "High-Pressure Line Construction for Alternating-Current Railways."

HIGH-PRESSURE LINE CONSTRUCTION FOR ALTERNATING-CURRENT RAILWAYS

Theodore Varney

Vol. xxiv—1905, pp. 123-142

Profusely illustrated description of overhead catenary construction used in United States, with proposed general plan for high-tension overhead construction based on one year's experience with single catenary in Indiana.

Discussion (including that of paper by George A. Damon on "Line Construction for High-Pressure Electric Railroads"), pp. 143-163, by Messrs. J. W. Lieb, Jr., F. N. Waterman, Calvert Townley, A. H. Armstrong, A. H. Babcock, C. O. Mailloux, Theodore Varney, and George F. Sever.

General remarks on the merits and limitations of high-trolley voltage. Experience of Ganz & Company with alternating-current trolley construction. Detailed description with illustrations of the Huber trolley system.

SHUNT AND COMPOUND-WOUND SYNCHRONOUS CONVERTERS FOR RAILWAY WORK

W. L. Waters

Vol. xxv—1906, pp. 549-553

Some advantages and disadvantages of compound-wound synchronous converters.

Discussion, pp. 554-557, by Messrs. J. B. Taylor, P. M. Lincoln, and W. L. Waters.

General remarks pro and con compound-wound synchronous converters.

ALTERNATING-CURRENT ELECTROLYSIS

J. L. R. Hayden

Vol. xxvi—1907, pp. 201-229

Experimental investigation of alternating-current electrolysis and chemical corrosion—tests with lead plates and various salt solutions with varying frequency and current density; tests with different soils and salt solutions in soil. Electrical method of protecting lead cable sheaths.

Discussion, incorporated with paper by George I. Rhodes on "Some Theoretical Notes on the Reduction of Earth Currents From Electric Railway Systems by Means of Negative Feeders."

ELECTROLYTIC CORROSION OF IRON AND STEEL IN CONCRETE

A. A. Knudson

Vol. xxvi—1907, pp. 231-246

An account of laboratory tests on structural steel embedded in concrete and subjected to a constant current. General conclusions as to electrolysis of bridge and building foundations and remedies therefor.

Discussion, incorporated with paper by George I. Rhodes on "Some Theoretical Notes on the Reduction of Earth Currents From Electric Railway Systems by Means of Negative Feeders."

SOME THEORETICAL NOTES ON THE REDUCTION OF EARTH CURRENTS FROM ELECTRIC RAILWAY SYSTEMS BY MEANS OF NEGATIVE FEEDERS

George I. Rhodes Vol. xxvi—1907, pp. 247-263

Mathematical and theoretical investigation of the relative efficiency of different return feeder systems in reducing stray currents. Equations for all quantities and graphical charts showing potential distribution and relative earth currents for different systems of return feeders.

Discussion (including that of paper by J. L. R. Hayden on "Alternating-Current Electrolysis" and paper by A. A. Knudson on "Electrolysis Corrosion of Iron and Steel in Concrete"), pp. 264-302, by Messrs. L. B. Stillwell, Frank N. Waterman, Paul Winsor, J. W. Corning, S. M. Kintner, Calvert Townley, George F. Sever, Albert F. Ganz, C. P. Steinmetz, J. L. R. Hayden, Philip Torchio, A. M. Schoen, W. R. C. Corson, F. A. C. Perrine, A. A. Knudson, H. W. Fisher, and R. A. L. Snyder.

General discussion of electrolysis. Experience with three-wire railway distribution system in Boston. Results of tests for alternating-current electrolysis. Protection of lead covered cables.

MOTOR GENERATORS VS. SYNCHRONOUS CONVERTERS

P. M. Lincoln Vol. xxvi—1907, pp. 303-311

Brief general analysis of the relative merits of synchronous converters, synchronous motor-generators and induction motor-generators from operative and economical standpoints.

Discussion, pp. 312-349, by Messrs. A. H. Armstrong, W. L. Waters, H. G. Stott, Ralph D. Mershon, Charles W. Stone, Charles F. Scott, Philip Torchio, B. A. Behrend, J. R. C. Armstrong, A. H. Babcock, F. G. Baum, Ernst J. Berg, R. G. Black, Edward P. Burch, H. W. Buck, O. B. Coldwell, W. R. C. Corson, Henry Floy, Clarence E. Gifford, William B. Jackson, R. S. Kelsch, Farley Osgood, John C. Parker, H. F. Parshall, A. C. Pratt, Leo Schuler, Carl Schwartz, Guido Semenza, B. C. Shipman, Miles Walker, and J. B. Whitehead.

General discussion of the relative merits of the synchronous converter, the synchronous motor-generator and the induction motor-generator with regard to reliability, voltage regulation, efficiency, cost, etc.

SINGLE-PHASE VS. THREE-PHASE GENERATION FOR SINGLE-PHASE RAILWAYS

A. H. Armstrong Vol. xxvi—1907, pp. 1367-1372

Brief discussion of the relative merits of different systems of deriving a single-phase railway distribution circuit from single-phase, three-phase and two-phase generators.

Discussion, pp. 1373-1376, by Messrs. P. M. Lincoln, Henry G. Stott, V. Karapetoff, John B. Taylor, William McClellan, Charles P. Steinmetz, and A. H. Armstrong.

Suggested remedies for distortion of three-phase system caused by single-phase load.

THE NEW HAVEN SYSTEM OF SINGLE-PHASE DISTRIBUTION WITH SPECIAL REFERENCE TO SECTIONALIZATION

W. S. Murray Vol. xxvii—1908, pp. 43-55

Classification of single-phase railway distribution, followed by a discussion of the advantages and disadvantages of the system used by the N. Y., N. H. & H. Railroad, with results of experience gained during six months of actual operation.

Discussion, pp. 56-65, by Messrs. W. S. Murray, L. B. Stillwell, W. B. Potter, and O. S. Lyford, Jr.

Additional data on the New Haven system; also very brief general description of the distribution system used on single track, single-phase railroads (Erie R. R. and Denver & Interurban R. R.).

SOME DEVELOPMENTS IN SYNCHRONOUS CONVERTERS

Chas. W. Stone Vol. xxvii 1908, pp. 181-189

Description of some mechanical details of the vertical type synchronous converter. Brief discussion of the advantages and disadvantages of different methods of voltage regulation including the booster and the split-pole methods.

Discussion, incorporated with paper by J. E. Woodbridge on "Some Features of Railway Converter Design and Operation."

SOME FEATURES OF SYNCHRONOUS CONVERTER DESIGN AND OPERATION

J. E. Woodbridge Vol. xxvii—1908, pp. 191-216

Analytical study of the three-phase and the six-phase synchronous converter, with a demonstration of the advantages of the self starting converters and a discussion of the theory and practice of compounding.

Discussion (included with the paper by W. L. Waters on "The Non-Synchronous Generator in Central Station and Other Work," and paper by Charles W. Stone on "Some Developments in Synchronous Converters"), pp. 217-254, by Messrs. C. F. Scott, Paul M. Lincoln, F. G. Clark, Charles P. Steinmetz, Comfort A. Adams, J. R. Bibbins, Philip Torchio, J. B. Taylor, W. L. Waters, J. E. Woodbridge, and C. W. Stone.

General discussion of the advantages and disadvantages of the induction generator from the operating standpoint. Split-pole *vs.* alternating-current booster methods of e. m. f. regulation for converters.

FROM STEAM TO ELECTRICITY ON A SINGLE-TRACK RAILROAD

J. B. Whitehead Vol. xxvii—1908, pp. 1139-1168

Analytical study of the relative merits of 6,600-volt single-phase, and 600-volt direct-current system for a certain single-track railway line—covering calculation of impedance of distribution system; construction of speed-current and power-time curves; cost of construction, maintenance and operation. Actual cost of steam operation.

Discussion, pp. 1169-1175, by Messrs. J. B. Whitehead, W. I. Slichter,

William McClellan, A. H. Babcock, A. W. Copley, Charles F. Scott, and S. H. Clarkson.

Results of actual tests on the constants of alternating current railway circuits—impedance, resistance and reactance for trolley and rails on four, two and one-track roads.

CONDUCTOR RAIL MEASUREMENTS

S. B. Fortenbaugh **Vol. xxvii 1908, pp. 1215-1229**

Results of tests on Metropolitan District Railway third and fourth rail conductors, giving leakage and insulation difficulties under various conditions of service; also complete data on resistance tests made on conductor rails.

No discussion.

EVEN HARMONICS IN ALTERNATING-CURRENT CIRCUITS

John B. Taylor **Vol. xxviii—1909, pp. 725-732**

Description of conditions under which even harmonics may be produced in commercial circuits, with special reference to the effect of stray direct-current on the performance of stationary transformers. Tests and oscillograms of transformer exciting current with stray direct current in the windings.

Discussion, pp. 773-736, by Messrs. Frederick Bedell, V. Karapetoff, Charles F. Scott, Charles P. Steinmetz, and John B. Taylor.

Production of even harmonics in alternators and effect of direct current in the windings of a transformer upon the losses.

ELECTRIC SYSTEM OF GREAT NORTHERN RAILWAY COMPANY AT CASCADE TUNNEL

Cary T. Hutchinson **Vol. xxviii—1909, pp. 1281-1319**

Description of design, construction, and operation of electrical equipment, with brief statement of the economies affected. Frictional resistance of steam locomotives and tests of regenerative control of induction motors.

Discussion, pp. 1320-1359, by Messrs. L. B. Stillwell, Cary T. Hutchinson, W. S. Murray, E. B. Katte, Bion J. Arnold, F. N. Waterman, J. H. Davis, L. R. Pomeroy, W. N. Smith, F. S. Denneen, W. I. Slichter, E. F. W. Alexanderson, C. L. deMuralt, Calvert Townley, Charles P. Steinmetz, Carl Schwartz, Frank J. Sprague, Edward P. Burch, Max Toltz, and E. Marshall.

General discussion of the relative merits of different systems of heavy electric traction, also of the economy and other advantages of electric over steam motive power. Additional description of the Great Northern System covering the overhead construction and the motor control and some of the difficulties in motor design.

THE APPLICATION OF PORCELAIN TO STRAIN INSULATORS

W. H. Kempton Vol. xxix—1910, pp. 967-974

Brief account of tests on several different types of strain insulators, giving the ultimate shearing, tensile and compressive stresses.

Discussion, incorporated with that of paper by W. N. Smith on "Electric Railway Catenary Trolley Construction."

ELECTRIC RAILWAY CATENARY TROLLEY CONSTRUCTION

W. N. Smith Vol. xxix—1910, pp. 975-1010

Review and discussion of current practice in catenary trolley construction, with design data and many illustrations of practical types of construction.

Discussion (including that of W. H. Kempton's paper on "Application of Porcelain to Strain Insulators"), pp. 1011-1036, by Messrs. Percy H. Thomas, C. J. Hixon, R. D. Coombs, R. C. Thurston, Charles R. Harte, Ralph D. Mershon, O. S. Lyford, Jr., W. H. Kempton, W. N. Smith, and Edwin B. Katte.

Remarks on properties of porcelain and design of strain insulators. Specifications for N. Y. C. R. R. high and low-tension strain insulators. Accounts of experiments and experience with catenary construction and current collectors of different types.

INTERPOLES IN SYNCHRONOUS CONVERTERS

B. G. Lamme and F. D. Newbury Vol. xxix—1910, pp. 1625-1653

Analytical discussion of commutation in direct-current generators and synchronous converters, with reference to the advantages and disadvantages of commutating poles. General summary of the factors that limit the economical output of various types of converters.

Discussion, pp. 1654-1678, by Messrs. Gano Dunn, H. F. T. Erben, C. P. Steinmetz, Jens Bache-Wiig, P. M. Lincoln, J. L. Burnham, C. W. Stone, C. A. Adams, and B. G. Lamme.

General remarks on the use of commutating poles in synchronous converters, with special reference to interurban service where load-factor is very low. Additional data on the design and limiting factors in synchronous converter construction.

D. SUB-STATIONS

THE STORAGE-BATTERY IN SUB-STATIONS

W. E. Goldsborough and P. E. Fansler Vol. xxii—1903, pp. 243-277

Description of Indiana Union Traction Company distribution system. Account and results of tests showing the efficiency of the various parts of the system, the performance and requirements of storage batteries in sub-stations. Graphic records of battery performance.

Discussion, incorporated with that of paper by Clarence Renshaw on "Some Notes on the Operation of Railway Motors in Service."

THE COMPARATIVE BEHAVIOR OF FLOATING AND BOOSTER-CONTROLLED BATTERIES ON FLUCTUATING LOADS

Lamar Lyndon Vol. xxii—1903, pp. 705-731

Analysis of the performance of an electric railway plant with storage battery arranged in the following ways: Floating battery in station; floating battery on line; battery and booster on line; battery on the line and booster in the station. Numerical examples and comparison of the merits of different systems.

Discussion, pp. 732-734, by Messrs. J. R. Appleton, J. L. Woodbridge, W. E. Goldsborough, J. W. Lieb, Jr., W. W. Donaldson, A. S. Hubbard, F. L. Flanders, and H. Etheridge.

Lead batteries for high discharge rates. E. m. f. characteristic of Edison battery under rapid discharge.

THE RELATION OF RAILWAY SUB-STATION DESIGN TO ITS OPERATION

Sydney W. Ashe Vol. xxiv—1905, pp. 1079-1096

Superficial discussion of certain factors which have a bearing on the choice and location of synchronous converter sub-station apparatus.

Discussion, incorporated with that of paper by C. W. Ricker on "Some Considerations Determining the Location of Electric Railway Sub-stations."

SOME CONSIDERATIONS DETERMINING THE LOCATION OF ELECTRIC RAILWAY SUB-STATIONS

C. W. Ricker Vol. xxiv—1905, pp. 1097-1106

Calculation of the most economical number of sub-stations for a given set of conditions, the secondary copper being proportioned by Kelvin's law in one instance and by limiting drop in the other.

Discussion (including that of paper by Sydney W. Ashe on "The Relation of Railway Sub-station Design to Its Operation"), pp. 1107-1118, by Messrs. H. A. Lardner, W. I. Slichter, John B. Taylor, H. G. Stott, E. M. Hewlett, D. B. Rushmore, R. B. Owens, William McClellan, and C. P. Steinmetz.

Relative merits of different methods of starting synchronous converters. Effect of maximum allowable drop upon location of synchronous converter sub-station.

THE DETERMINATION OF THE ECONOMIC LOCATION OF SUB-STATIONS IN ELECTRIC RAILWAYS

Gerhard B. Werner Vol. xxvii—1908, pp. 1201-1212

Development of a formula for determining the most economical number of sub-stations for a given single-phase railway system.

Discussion, pp. 1213-1214, by Messrs. C. J. Hopkins, Gerard B. Werner, and P. M. Lincoln.

E. OPERATION

AN ELECTRIC CAR LIGHTING SYSTEM

W. L. Bliss Vol. xxi—1903, pp. 133-154

Description of an axle-driven car lighting system with generator and storage battery, the e. m. f. being controlled by special booster. Detailed explanation of the construction and mode of operation, so as to produce constant e. m. f. under usual conditions of railway service.

Discussion, incorporated with that of paper by George D. Shepardson on "Some of the Problems of Electric Train Lighting."

AXLE-LIGHTING

Elmer A. Sperry Vol. xxi—1903, pp. 155-162

Reference to some of the earliest electric car lighting installations. Criticisms of present methods and announcement of method employing an axle-driven constant-speed generator.

Discussion, incorporated with that of paper by George D. Shepardson on "Some of the Problems of Electric Train Lighting."

AN AXLE-LIGHT SYSTEM OF TRAIN LIGHTING

Arthur J. Farnsworth Vol. xxi—1903, pp. 163-172

Description of axle-driven car lighting system with generator e. m. f. kept constant by automatically varying resistance of field circuit. Battery voltage also compensated with variable resistance.

Discussion, incorporated with that of paper by George D. Shephardson on "Some of the Problems of Electric Train Lighting."

SOME OF THE PROBLEMS OF ELECTRIC TRAIN LIGHTING

Geo. D. Shepardson Vol. xxi—1903, pp. 173-178

Dates of some of the earliest applications of electricity to lighting of cars. Short outline of the requirements of train lighting and discussion of some of the difficulties encountered in each typical system.

Discussion (including that of paper by W. L. Bliss on "An Electric Car Lighting System," paper by Elmer A. Sperry on "Axle-Lighting," and paper by Arthur J. Farnsworth on "Axle-Light System of Train Lighting"), pp. 179-195 and 208-227, by C. F. Scott, Professor Carhart, Lamar Lyndon, W. L. Bliss, Max Von Recklinghausen, George W. Blodgett, C. W. Hogan, Charles B. Lockwood, J. R. Sloane, Elmer A. Sperry, James F. McElroy, Carl Hering, Charles J. Dudley, Ralph W. Pope, Hugh Lesley, C. W. Woodward, Charles Hewitt, W. C. L. Eglin, Charles J. Reed, Philip L. Spalding, John B. Klumpp, J. S. Peck, N. W. Storer, A. H. Masters, B. B. Abry, J. M. Campbell, P. M. Lincoln, A. H. Armstrong, C. P. Steinmetz, W. I. Slichter, and R. Neil Williams.

General remarks on train lighting. Relative merits of engine-driven and axle-driven units. Difficulties and limitations of different systems. Description of actual equipments. Description of Gould car lighting system. Cost of operating various lighting systems—oil, gas, and electric.

A SYSTEM OF ELECTRIC LIGHTING FOR CARS

Jas. F. McElroy — Vol. xxi—1903, pp. 197-207

Description of the McElroy axle-driven train lighting system, the e. m. f. being kept constant by a variable resistance operated by a motor and controlled through a compound solenoid.

No discussion.

ELECTRICAL FEATURES OF BLOCK SIGNALING

L. H. Thullen — Vol. xxiv—1905, pp. 577-589

Brief remarks on signal systems used on several electric railways. Effect of air-gap on impedance of inductive bonds carrying various amounts of direct current.

Discussion, p. 590, by Mr. H. G. Stott.

TRACK-CIRCUIT SIGNALING ON ELECTRIFIED ROADS

L. Frederick Howard — Vol. xxvi—1907, pp. 1535-1550

Description of various types of single-rail and double-rail track-cirsuit signaling systems for direct-current and alternating-current roads, with circuit diagrams of systems used on some of the leading electric railways.

Discussion, pp. 1551-1553, by Messrs. Charles F. Scott, Henry G. Stott, Charles A. Perkins, and L. F. Howard.

THE LOG OF THE NEW HAVEN ELECTRIFICATION

W. S. Murray — Vol. xxvii—1908, pp. 1613-1664

Detailed account of the troubles encountered in the first four months' operation of the electric zone of the New Haven road, covering power plant (three-phase turbo-generators load on one phase), distribution system and locomotives. Complete tabular and graphical logs of delays, repairs, locomotive performance, etc., supplemented by measures to overcome the various difficulties encountered.

Discussion, pp. 1665-1719, by Messrs. L. A. Ferguson, Calvert Townley, B. G. Lamme, L. B. Stillwell, E. B. Katte, H. P. Davis, Charles P. Steinmetz, Philip Torchio, Minor M. Davis, B. A. Behrend, H. F. Parshall, A. H. Armstrong, N. W. Storer, O. S. Lyford, Jr., W. N. Smith, Philip Dawson, Ivan Ofverholm, C. E. Eveleth, and W. S. Murray.

Additional information on the performance of the New Haven single-phase locomotives, the generators and the improved circuit breaking apparatus. Comparison of the New Haven single-phase locomotive and the New York Central direct-current locomotive. Operation experience with the single-phase line of the Erie Railroad. Overhead catenary construction of the London, Brighton and South Coast Railway.

HEADLIGHT TESTS

C. Francis Harding and A. N. Topping Vol. xxix—1910, pp. 1053-1081

Experimental investigation of locomotive headlights to ascertain the relative merits of ordinary oil and powerful electric headlights. Road tests on the operation of colored light signals and obstructions on the tracks. Laboratory tests of illumination characteristics; spectral intensities, and reflections from signal lamp roundels with different types of headlights. Tabulated and plotted data and characteristic curves of the performance of the different types of headlights.

Discussion, pp. 1082-1089, by Messrs. C. A. B. Halvorson, Jr., John B. Taylor, George H. Stickney, Harry Barker, C. P. Steinmetz, Charles F. Scott, George A. Hoadley, Harry P. Wood, J. C. Lincoln, and C. Francis Harding.

General discussion of high-power *vs.* low-power headlights, with some results of tests.

F. INDUSTRIAL RAILWAYS AND TELPHERAGE

TELPHERAGE

Chas. M. Clark Vol. xix—1902, pp. 435-453

Brief outline of history of development of telpherage. Description of present methods of construction and operation, profusely illustrated with line drawings and photographs of different types of machinery and methods of application.

Discussion (included with that of paper by George F. Sever on "Power Consumption of Elevators Operated by Alternating and Direct-Current Motors"), pp. 454-486, by Messrs. Charles P. Steinmetz, John D. Ihlder, A. V. Abbott, Philip Torchio, Ralph D. Mershon, George F. Sever, Arthur Williams, Edward P. Thompson, F. V. Henshaw, H. G. Stott, Douglass Burnett, F. H. Taylor, M. Wellman, Henry H. Humphrey, P. B. Woodworth, R. H. Pierce, James Lyman, David Lofts, J. W. Mabbs, A. D. Ayres, M. Hobart, A. H. Cutler, E. B. Clark, and L. A. Nichols.

Load characteristics and power requirements of elevator service. Alternating-current *vs.* direct-current motors for elevator service. Acceleration, speed and energy consumption in electric elevator service.

STORAGE-BATTERY INDUSTRIAL LOCOMOTIVES

F. L. Sessions Vol. xxii—1903, pp. 109-123

General discussion of storage-battery locomotives—their advantages; methods of operating the battery; calculation of battery rating for given service; motor control, etc. Tables for facilitating the calculation of storage-battery rating, with numerical example illustrating their use.

Discussion, pp. 124-131, by Messrs. Edgar H. Berry, F. L. Sessions, and Elmer A. Sperry.

General remarks on storage-battery performance in industrial locomotive service, and criticisms of author's tables.

G. CANAL BOAT HAULAGE

NOTES ON ELECTRIC HAULAGE OF CANAL BOATS

Lewis B. Stillwell and H. St. Clair Putnam **Vol. xxvii—1908, pp. 227-316**

Description of tests made on the Lehigh Canal, to determine the power requirements, the speed and length of tow and the relative merits of mules, electric locomotives and electric tractors. A general discussion of canal-boat resistance comparing these tests with the results of those of other tests.

Discussion, pp. 317-320, by Messrs. Richard Lamb, Charles P. Steinmetz, and L. B. Stillwell.

18. LIGHT LIGHTING AND LAMPS

A. LIGHT PRODUCTION AND MEASUREMENT

A NOTE ON AN ACETYLENE-IN-OXYGEN FLAME

Clayton H. Sharp — Vol. xix—1902, pp. 51-54

Description of an acetylene flame burner which might be used as a standard of intensity. Spectrophotometric curve of acetylene and other flames.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

THE PRESENT STATUS OF THE QUESTION OF A STANDARD OF LIGHT

Clayton H. Sharp — Vol. xix—1902, pp. 55-57

Brief reference to some of the shortcomings of the present standards of luminous intensity. Advantages of acetylene flame as standard.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

PHOTOMETRY AND ILLUMINATION

Chas. F. Scott — Vol. xx—1902, pp. 55-57

AN INTEGRATING PHOTOMETER FOR GLOW LAMPS AND SOURCES OF LIGHT INTENSITY

Chas. P. Matthews — Vol. xx—1902, pp. 59-70

Theory, design, construction and operation of a special intensity photometer invented by the author for use in making photometric measurements of incandescent lamps and flames.

Discussion, incorporated with that of paper by Clayton H. Sharp on "The Commercial Accuracy of Photometrical Measurements."

SOME METHODS OF PHOTOMETRY AS APPLIED TO INCANDESCENT LAMPS

J. T. Marshall, — Vol. xx—1902, pp. 77-85

A description of method of calibrating and using sliding scale photometer for commercial testing and inspection of incandescent lamps.

Discussion, incorporated with that of paper by Clayton H. Sharp on "The Commercial Accuracy of Photometrical Measurements."

THE COMMERCIAL ACCURACY OF PHOTOMETRICAL MEASUREMENTS

Clayton H. Sharp — Vol. xx—1902, pp. 87-93

Experimental investigation of the limits of accuracy in different classes of photometrical measurements.

Discussion (including that of paper by Charles P. Matthews on "Integrating Photometer for Glow Lamps and Sources of Light Intensity;" paper by Douglass Burnett on "Distributed Lighting," and paper by J. T.

Marshall on "Some Methods of Photometry as Applied to Incandescent Lamps"), pp. 94-110, by Messrs. Douglass Burnett, Edward L. Nichols, Francis R. Upton, L. B. Marks, W. S. Howell, F. S. Smith, Edward B. Rosa, Calvin W. Rice, William J. Hammer, W. S. Stratton, Clayton H. Sharp, J. T. Marshall, Charles F. Scott, Charles P. Matthews, Edward P. Thompson, Alex J. Wurts, R. H. Henderson, Max Von Reckinghausen, P. M. Lincoln, N. W. Storer, and F. W. Jones.

Merits of mean spherical candle-power method of rating illuminants. Methods of measuring illumination. Description of Cooper-Hewitt mercury vapor lamp.

TRANSFORMATION OF ELECTRIC POWER INTO LIGHT

Charles P. Steinmetz Vol. xxv—1906, pp. 789-813

Analytical discussion of the different methods of transforming electric energy into light, covering incandescent solids, selective radiation and luminescence of vapors and gases. Ideal efficiencies of the various methods and practical means of approaching them with the modern types of illuminants.

Equations for volt-ampere characteristics of various kinds of arcs. Theory of arc conduction and e. m. f. rectification.

Discussion, incorporated with paper by Clayton H. Sharp on "New Types of Incandescent Lamps."

PRIMARY STANDARD OF LIGHT

Charles P. Steinmetz Vol. xxvii—1908, pp. 1319-1324

Criticism of primary standard based on energy of radiation, recommending standard composed of three component colors of definite wave lengths.

Discussion, pp. 1325-1339, by Messrs. A. E. Kennelly, Edwin P. Hyde, W. S. Franklin, Carl Hering, Clayton H. Sharp, C. A. Perkins, John B. Taylor, E. B. Rosa, H. S. Carhart, and Charles P. Steinmetz.

General remarks on Steinmetz' proposed standard. Motion carried to refer question of establishing standard to the Bureau of Standards.

B. LIGHTING

METHODS OF ILLUMINATION

Louis Bell Vol. xix—1902, pp. 5-27

A discussion on the physiological and practical side of illumination. Outline of the qualities that should be possessed by illuminants for practical illumination. Discussion of the present status of light standards and the art of photometric measurements. Requirements of street lighting and general indoor lighting, with characteristics and relative merits of various illuminants.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

STREET ILLUMINATION AND UNITS OF LIGHT

W. D'A Ryan **Vol. xix–1902, pp. 29-41**

Photometric study of arc lamps for street lighting, showing the effects of variation, wandering and flicker of the arc on the distribution of the light, and of candle-power and spacing on the energy consumption for a given illumination. Tests on open and enclosed direct-current and alternating-current arc lamps.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

SOME COMMON DIFFICULTIES IN EXTERIOR ILLUMINATION

S. Everett Doane **Vol. xix–1902, pp. 43-46**

Consideration of the actual value of illumination to observer, showing effect of candle-power and spacing of lamps thereon. Advantages of incandescent lamps for street lighting.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

DISTRIBUTED LIGHTING

Douglass Burnett **Vol. xx–1902, pp. 71-76**

General discussion of indirect lighting, pointing out the effects of reflection and diffusion on illumination. Suggested method of measuring illumination directly. Bibliography.

Discussion, incorporated with that of paper by Clayton H. Sharp on "The Commercial Accuracy of Photometrical Measurements."

RAILWAY TRAIN LIGHTING

Chas. F. Scott **Vol. xxi–1903, pp. 129-131**

AN ELECTRIC CAR LIGHTING SYSTEM.

W. L. Bliss **Vol. xxi—1903, pp. 133-154**

Description of an axle-driven car lighting system with generator and storage battery, the e. m. f. being controlled by special booster. Detailed explanation of the construction and mode of operation, so as to produce constant e. m. f. under usual conditions of railway service.

Discussion, incorporated with that of paper by George D. Shepardson on "Some of the Problems of Electric Train Lighting."

AXLE-LIGHTING

Elmer A. Sperry **Vol. xxi–1903, pp. 155-162**

Reference to some of the earliest electric car lighting installations. Criticisms of present methods and announcement of method employing an axle-driven constant-speed generator.

Discussion, incorporated with that of paper by George D. Shepardson on "Some of the Problems of Electric Train Lighting."

AN AXLE-LIGHT SYSTEM OF TRAIN-LIGHTING

Arthur J. Farnsworth — Vol. xxi—1903, pp. 163-172

Description of axle-driven car lighting system with generator e. m. f. kept constant by automatically varying resistance of field circuit. Battery voltage also compensated with variable resistance.

Discussion, incorporated with that of paper by George D. Shepardson on "Some of the Problems of Electrain Train Lighting."

SOME OF THE PROBLEMS OF ELECTRIC TRIAN LIGHTING

Geo. D. Shepardson — Vol. xxi—1903, pp. 173-178

Dates of some of the earliest applications of electricity to lighting of cars. Short outline of the requirements of train lighting and discussion of some of the difficulties encountered in each typical system.

Discussion (including that of paper by W. L. Bliss on "An Electric Car Lighting System," paper by Elmer A. Sperry on "Axle-Lighting," and paper by Arthur J. Farnsworth on "Axle-Light System of Train Lighting"), pp. 179-195 and 208-227, by C. F. Scott, Professor Carhart, Lamar Lyndon, W. L. Bliss, Max Von Recklinghausen, George W. Blodgett, C. W. Hogan, Lockwood, J. R. Sloane, Elmer A. Sperry, James F. McElroy, Carl Hering, Charles B. Dudley, Ralph W. Pope, Hugh Lesley, C. W. Woodward, Charles Hewitt, W. C. L. Eglin, Charles J. Reed, Philip L. Spalding, John B. Klumpp, J. S. Peck, N. W. Storer, A. H. Masters, B. B. Abry, J. M. Campbell, P. M. Lincoln, A. H. Armstrong, C. P. Steinmetz, W. I. Slichter, and R. Neil Williams.

General remarks on train lighting. Relative merits of engine driven and axle-driven units. Difficulties and limitations of different systems. Description of actual equipments. Description of Gould car lighting system. Cost of operating various lighting systems—oil, gas, and electric.

A SYSTEM OF ELECTRIC LIGHTING FOR CARS

Jas. F. McElroy — Vol. xxi—1903, pp. 197-207

Description of the McElroy axle-driven train lighting system, the e. m. f. being kept constant by a variable resistance operated by a motor and controlled through a compound solenoid.

No discussion.

NOTES ON THE LIGHTING OF CHURCHES

Edwin R. Weeks — Vol. xxv—1906, pp. 643-648

General remarks on church lighting with outlet plan, and excerpts from the specifications for the Westminster Church in Kansas City.

No discussion.

ILLUMINATION FOR INDUSTRIAL PLANTS

G. H. Stickney — Vol. xxix—1910, pp. 139-146

General discussion of lighting of manufacturing processes, with due regard to workmen, character of the building and processes of manufac-

ture, supplemented with a short characterization of the different types of lamps with reference to their industrial uses.

Discussion, incorporated with that of Mr. Walter B. Nye's paper on "The Requirements for an Induction Motor From the User's Point of View."

HEADLIGHT TESTS

C. Francis Harding and A. N. Topping Vol. xxix—1910, pp. 1053-1081

Experimental investigation of locomotive headlights to ascertain the relative merits of ordinary oil and powerful electric headlights. Road tests on the operation of colored light signals and obstructions on the tracks. Laboratory tests of illumination characteristics, spectral intensities, and reflections from signal lamp roundels with different types of headlights. Tabulated and plotted data and characteristic curves of the performance of different types of headlights.

Discussion, pp. 1082-1089, by Messrs. C. A. B. Halvorson, Jr., John B. Taylor, George H. Stickney, Harry Barker, C. P. Steinmetz, Charles F. Scott, George A. Hoadley, Harry P. Wood, J. C. Lincoln, and C. Francis Harding.

General discussion of high power *vs.* low power headlights, with some results of tests.

C. LAMPS

DEVELOPMENT OF THE NERNST LAMP IN AMERICA

Alexander Jay Wurtz Vol. xviii—1901, pp. 545-570

Account of the experimental investigation involved in commercial development of the Nernst lamp by the Westinghouse Company, covering the construction and the performance characteristics of the component parts under various conditions; also a description of the construction, performance and maintenance of the complete lamp in its commercial form.

Discussion, pp. 571-587, by Messrs. George W. Blodgett, A. J. Wurts, Carl Hering, J. W. Howell, Charles P. Steinmetz, W. J. Hammer, Oberlin Smith, L. B. Stillwell, P. K. Stern, Harry Alexander, and A. J. Rowland.

General discussion of the characteristics of the Nernst lamp and its probable features.

AN IMPROVED APPARATUS FOR ARC-LIGHT PHOTOMETRY

Charles P. Matthews Vol. xviii-1901, pp. 677-689

Development of theory and description of construction and operation of Matthews indicating photometer for arc lamps.

Discussion, pp. 690-697, by Messrs. Charles P. Steinmetz, Clayton H. Sharp, Charles P. Matthews, C. J. Spencer, George T. Hanchett, F. S. Woodward, and A. E. Kennelly.

General remarks on operation and construction of the photometer.

THE INCANDESCENT LAMP OF TO-DAY

Jno. W. Howell — Vol. xix—1902, pp. 47-49

Brief statement of the most prominent characteristics of carbon filament lamps.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

ELECTRIC GAS LAMPS AND GAS ELECTRICAL RESISTANCE PHENOMENA

Peter Cooper Hewitt — Vol. xix—1902, pp. 59-65

Brief account of some of the difficulties encountered in developing the mercury vapor arc lamp. Choice of dimensions of gas column, overcoming the initial negative resistance, etc.

Discussion, incorporated with that of paper by William J. Hammer on "Edison's Tungstate of Calcium Lamp—The Nernst Lamp—Radium, Polonium and Actium."

EDISON'S TUNGSTATE OF CALCIUM LAMP—THE NERNST LAMP—RADIUM, POLONIUM AND ACTINUM

William J. Hammer — Vol. xix—1902, pp. 67-75

Demonstration of Edison X-Ray lamp and the Nernst lamp. Superficial review of the properties of radium. Appendix contains notes by Professor Curie on the properties of radium.

Discussion (including that of paper by Louis Bell on "Methods of Illumination;" paper by W. D'A. Ryan on "Street Illumination and Units of Light;" paper by S. Everett Doane on "Some Common Faults in Exterior Illumination;" paper by John W. Howell on "The Incandescent Lamp of To-day;" paper by Clayton H. Sharp on "A Note on an Acetylene-in-Oxygen Flame;" paper by Clayton H. Sharp on "The Present Status of the Question of a Standard of Light;" and paper by Peter Cooper Hewitt on "Electric Gas Lamps and Gas Electrical Resistance Phenomena"), pp. 76-92, by Messrs. C. P. Steinmetz, J. W. Lieb, Jr., A. E. Wolff, A. E. Kennelly, Louis Bell, C. A. Doremus, S. E. Doane, George T. Hanchett, W. D'A. Ryan, John W. Howell, W. J. Hammer, T. J. Johnston, Van Renssalaer Lansingh, T. B. Woodworth, Morgan Brooks, and W. B. Hale.

General discussion of light production and illumination—incandescence, selective radiation, electro-luminescence, indirect lighting. Present status of primary standards. Sources of error with flame standards.

THE MERCURY VAPOR LAMP

Vol. xxii—1903, pp. 71-85

General discussion of the early development of the mercury vapor lamp, followed by a description of the mode of operation of the mercury vapor lamp and the converter. Uses to which this apparatus may be put.

Discussion, pp. 85-90, by Messrs. Percy H. Thomas, C. O. Mailloux.

Properties and performance characteristics of mercury vapor apparatus.

COMMENTS ON REMARKS MADE BY COL. R. E. B. CROMPTON BEFORE THE INTERNATIONAL ELECTRICAL CONGRESS AT ST. LOUIS

John W. Howell Vol. xxiv—1905, pp. 453-462

Experimental investigation of the quality of English makes of 220-volt carbon filament lamps, comparing them with American lamps as judged by specific consumption, uniformity and accuracy of rating and life.

Discussion, p. 463, by Messrs. J W. Lieb, Jr., Charles P. Steinmetz, and J. W. Howell.

A NEW CARBON FILAMENT

John W. Howell Vol. xxiv—1905—pp. 839-847

Brief description of process of graphitizing filaments, together with results of tests showing effect of firing temperature on resistance.

Discussion, pp. 848-849, by Messrs. H. N. Potter, and John W. Howell.

NOTES ON THE POWER-FACTOR OF THE ALTERNATING-CURRENT ARC

George D. Shepardson Vol. xxiv—1905, pp. 881-887

Brief account of tests on enclosed and open carbon arcs, showing the effect of e. m. f. wave form upon power-factor. Oscillographs.

No discussion.

SOME FUNDAMENTAL CHARACTERISTICS OF MERCURY VAPOR APPARATUS

Percy H. Thomas Vol. xxv—1906, pp. 601-626

Electrical characteristics of mercury arc lamps and converters, with theoretical explanation of mode of operation and description of ways in which the various mercury vapor apparatus are used.

Discussion, pp. 627-633, by Messrs. C. P. Steinmetz, S. S. Wheeler, H. C. Wirt, and P. H. Thomas.

Explanation of performance of mercury arc on same basis as the ordinary arc, with equation of e. m. f. consumed. Principles of conservation of energy used to explain operation of mercury vapor apparatus as opposed to negative electrode resistance idea.

NEW TYPES OF INCANDESCENT LAMPS

Clayton H. Sharp Vol. xxv—1906, pp. 815-847

Brief description of various foreign processes of manufacturing tungsten filaments, together with physical and electrical characteristics of tungsten, tantalum and osmium filaments. Light distribution, specific consumption, life, flicker frequency and other properties of metallic filament and graphitized filament lamps from tests, much test data given in the form of curves and tables.

Discussion (included with paper by Charles P. Steinmetz on "Transformation of Electric Power into Light"), pp. 849-864, by Messrs. Herschel C. Parker, John W. Howell, Percy H. Thomas, Walter G.

Clark, C. W. Hogan, Charles P. Steinmetz, William J. Hammer, and W. S. Franklin.

General remarks on practical methods of producing light with modern illuminants. Ideal efficiencies. Theory of light emission by gas and vapor molecules, also theoretical discussion of selective radiation and selective excitation of a light giving substance.

LIGHT FROM GASEOUS CONDUCTORS WITHIN GLASS TUBES—THE MOORE LIGHT

D. McFarlan Moore Vol. xxvi—1907, pp. 605-641

Description of the construction and mode of operation of the Moore tube lamp, together with illumination tests, performance characteristics, life, specific energy consumption, etc., also comparative tests with other illuminants.

Discussion, pp. 642-664, by Messrs. Gano Dunn, C. P. Steinmetz, Percy H. Thomas, Clayton H. Sharp, John W. Howell, Leon Gaster, D. McFarlan Moore, and R. A. Fessenden.

Criticism of methods of illumination measurements and comparative efficiency figures given in the paper. Additional data and tests on the performance of the Moore tube installed in the Engineering Societies' Building.

ELECTRICITY IN MINES

George R. Wood Vol. xxvii—1908, pp. 1571-1581

Brief outline of the ordinary methods of mining coal in Pennsylvania, with description of some of the typical machinery and coal mining electric plants.

Discussion, pp. 1582-1583, by Messrs. F. L. Sessions, W. A. Thomas, and H. W. Fisher.

Saving accomplished by use of low-pressure turbines in coal mines.

METAL FILAMENT LAMPS

John W. Howell, Vol. xxix—1910, pp. 927-938

Brief description of the physical, electrical and thermal properties, operative characteristics and testing of metallic filament lamps.

Discussion, pp. 939-960, by Messrs. Clayton H. Sharp, John B. Taylor, Farley Osgood, William L. Nodell, John W. Howell, G. S. Merrill, M. D. Copper, and H. D. Blake.

Remarks on cyclic and initial overshooting, life and rating; also brief account and results of exhaustive experimental investigation of the performance of tungsten lamps.

DUCTILE TUNGSTEN

W. D. Coolidge Vol. xxix—1910, pp. 961-965

Brief outline of difficulties encountered in the working of tungsten for filaments, together with some of the properties of drawn tungsten filaments.

No discussion.

TUNGSTEN LAMPS

G. S. Merrill

Vol. xxix—1910, pp. 1709-1729

Description of the general method of manufacturing and of the performance characteristics of the tungsten lamps. Explanation of the heat efficiency of this type of lamp.

No discussion.

19. ELECTRICITY IN THE ARMY AND NAVY

CIVILIAN CO-OPERATION IN THE DEVELOPMENT OF ELECTRICAL DEFENSES FOR MILITARY PURPOSES

Caryl D. Haskins — Vol. xix—1902, pp. 559-562

Brief mention of some of the uses of electricity in the army, indicating the field in which the civilian engineer could be of most service in case of an emergency.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defense."

ELECTRICITY IN ITS APPLICATION TO SUBMARINE MINES

Capt. John Stephen Sewell — Vol. xix—1902, pp. 563-568

General discussion of the requirements of electrically operated mines, bringing out the difficulties encountered in the design of such systems.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

WIRELESS TELEGRAPHY IN THE UNITED STATES NAVY

Lieut. A. M. Beecher — Vol. xix—1902, pp. 569-578

Description of the general principles of wireless telegraph systems and account of what has actually been done in the navy.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

ELECTRICITY IN THE NAVY

Lieut. Harry George — Vol. xix—1902, pp. 579-628

General description of the applications of electricity on board war ships, with brief outline of the specifications for the generating, wiring and apparatus plant—construction, properties and acceptance tests, as well as the power requirements and mode of operation of various special apparatus such as ammunition hoists, turrets, signal lights and telegraphs, etc.

Discussion, included with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

THE REASONS FOR THE CHANGE OF THE NAVY STANDARD VOLTAGE FROM 80 TO 125

Lieut. W. V. N. Powelson — Vol. xix—1902, pp. 643-664

History of voltages used in the navy. Table showing relative costs and weights of wiring materials for operation at 80 volts and at 125 volts.

Detailed discussion of the reasons for adopting 125 volts as the navy standard.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

ELECTRICITY IN PROMINENT SEA COAST DEFENCES

Major Geo. W. Goethals Vol. xix—1902, pp. 665-683

Description of the general character and arrangement of sea coast forts, giving the requirements and characteristics of the electric service, also the considerations which enter into the drawing up of specifications for the electric equipment of such plants.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

SUB-MARINE CABLE TESTING IN THE SIGNAL CORPS U. S. ARMY

Vol. xix—1902, pp. 685-695

General description of the electrical and mechanical specifications for Signal Corps cable and the tests which it must undergo. Change of insulation resistance with temperature treated in detail, and a chart given for reducing resistances to standard temperatures.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

ELECTRICITY IN THE NAVY

Walter M. McFarland Vol. xix—1902, pp. 697-705

Brief general review of the uses of electricity in the navy. Criticism of the low temperature limit required by navy specifications. Advantages of alternating current for use on board ship and in navy yards.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

ELECTRICITY IN THE SIGNAL CORPS

Lieut. Col. Samuel Reber Vol. xix—1902, pp. 707-724

Scope of the duties of the Army Signal Corps. Telegraph and telephone construction in the field and in fortresses. Detailed description of signal apparatus used in the army.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

EMERGENCY ENGINEERING FOR HARBOR DEFENCE

Louis Bell Vol. xix—1902, pp. 725-733

Account of experiences of the Volunteer Electrical Corps formed at Boston during the Spanish War for the construction of mining defences.

Discussion (including that of paper by Carl B. Haskins on "Civilian Coöperation in the Development of Electrical Defences for Military Purposes," by Captain John Stephen Sewell on "Electricity in Its Application to Submarine Mines;" paper by Lieutenant A. M. Beecher on "Wireless Telegraphy in the U. S. Navy;" paper by Lieutenant Harry George on "Electricity in the Navy;" paper by Captain Edgar Russel on "Military Cable System of the Philippines;" paper by Lieutenant W. V. N. Powelson on "The Reasons for the Change of the Navy Standard

Voltage from 80 to 125," by Major George W. Goethals on "Electricity in Prominent Sea Coast Defences;" paper by Townsend Wolcott on "Submarine Cable Testing in the Signal Corps,—U. S. Army;" paper by Walter M. McFarland on "Electricity in the Navy," and by Lieutenant Colonel Samuel Reber on "Electricity in the Signal Corps"), pp. 734-742, by Messrs. Samuel Reber, Harry George, Eugene Griffin, A. V. Abbott, A. M. Beecher, A. W. Greely, Calvin W. Rice, and George T. Hanchett.

Defence of the navy specifications. General discussion of wireless telegraphy.

20. MISCELLANEOUS APPLICATIONS OF ELECTRICITY

A. ELECTROCHEMISTY AND METALLURGY

THE ELECTROCHEMICAL INDUSTRIES

Samuel Sheldon — Vol. xix—1902, pp. 281-294

Brief description of various commercial electro-chemical processes—electro-deposition of metals; production of organic and inorganic substances; process involving the use of electric furnaces. Also brief description of electrolytic condensers, rectifiers and interrupters.

Discussion, incorporated with that of paper by W. R. Whitney on "Colloids."

THE ELECTRIC FURNACE IN INDUSTRIAL CHEMISTRY

Chas. B. Jacobs — Vol. xix—1902, pp. 295-307

Description of several important processes carried on with electric furnaces, and discussion of the characteristics and properties of carbides and silicides.

Discussion, incorporated with that of paper by W. R. Whitney on "Colloids."

ELECTROLYTIC CONDUCTION WITHOUT ELECTRODES

Carl Hering — Vol. xix—1902, pp. 309-315

Theoretical discussion of possible methods of producing and measuring electric current in a purely liquid conductor.

Discussion, incorporated with that of paper by W. R. Whitney on "Colloids."

LOW GRADE ORES

N. S. Keith — Vol. xix—1902, pp. 333-341

Description of a process and plant for recovering copper from ores of an old mine near New York City.

Discussion, incorporated with that of paper by W. R. Whitney on "Colloids."

ON THE MODIFICATIONS IN HERING'S LAWS OF FURNACE ELECTRODES INTRODUCED BY INCLUDING VARIATIONS IN ELECTRIC AND THERMAL RESISTIVITY

A. E. Kennelly — Vol. xxix—1910, pp. 465-481

Theoretical and mathematical investigation of the losses in furnace electrodes, taking into account variations in the physical constants with temperature. The treatment includes full development of formulas and illustrates their application by numerical examples.

Discussion, pp. 482-484, by Messrs. Carl Hering, and L. B. Stillwell. General remarks on laws for the proportioning of electrodes.

THE PROPORTIONING OF ELECTRODES FOR FURNACES

Carl Hering — Vol. xxix—1910, pp. 485-534

Analytical and experimental investigation of furnace electrode losses under furnace conditions with electrodes of various materials, developing simple laws for proportioning electrodes to operate with minimum loss. The tests, among other properties, give the electric resistivity and the thermal conductivity of graphite, iron and copper over wide ranges of temperature.

Discussion, pp. 535-545, by Messrs. A. E. Kennelly, and E. F. Northrup. Thermal conductivities and temperature coëfficients of electrode materials. Development of other formulas for proportioning electrodes.

B. MINING

ELECTRICITY IN MOUNTAIN MINES

Frank W. Brady — Vol. xviii—1901, pp. 191-201

Difficulties encountered in mountain transportation of machinery. Description of typical cases of mountain transportation: burro, aerial, wire rope and wagon road.

Discussion, pp. 202-206, by Messrs. N. S. Keith, C. O. Mailloux, Ralph W. Pope, and Carl Hering.

THE ELECTRICAL EQUIPMENT OF A GOLD DREDGE

Ralph L. Montagu — Vol. xxii—1903, pp. 507-518

Description of gold dredge and the power requirements of the various machines used in its operation. Directions and diagrams for wiring a typical dredge.

No discussion.

SOME NOTES ON CERTAIN UNDERGROUND HOISTING PROBLEMS ON THE WITWATERSRAND

A. W. K. Pierce — Vol. xxii—1903, pp. 553-559

General discussion of the advantages of electric motive power for mine hoists. The nature of the load requirements, choice of the acceleration curve and method of control.

No discussion.

ELECTRIC MINE HOISTS

D. B. Rushmore and K. A. Pauly — Vol. xxix—1910, pp. 249-290

General discussion of the advantages of electric mine hoisting, with typical hoist load diagrams for different types of hoists, followed by brief description and analysis of the performance of four typical electrical hoisting systems. Estimated cost and energy consumption.

Discussion, incorporated with that of Mr. Wilfred Sykes' paper on "Large Electric Hoisting Plants."

LARGE ELECTRICAL HOISTING PLANTS

Wilfred Sykes Vol. xxix—1910, pp. 291-322

Analytical and graphical methods of calculating the load diagrams of various types of hoists, followed by a description of the Ilgner, the converter, and the booster balancing systems, together with instructions for pre-determining their performance curves under given conditions. Economy of electric hoisting.

Discussion, including that of paper by Messrs. D. B. Rushmore and K. A. Pauly on "Electric Mine Hoists," pp. 323-325, by Mr. Edward J. Cheney.

Formulas for the calculation of motor horse-power and motor rating for hoisting service.

TESTS OF AN ILGNER ELECTRIC HOIST

R. R. Seeber, Vol. xxix—1910, pp. 327-337

Brief description of electric hoisting plant of Winona Copper Company, with an account of tests and results. Comparison of actual coal-to-rock ratios for electric and steam hoists and observed performance curves of the Ilgner system.

No discussion.

C. STEEL MILLS

CHARACTERISTICS OF MOTORS FOR LARGE SHEARS

Brent Wiley Vol. xxvii—1908, pp. 321-334

Discussion of the characteristics of different types of direct-current and alternating-current motors for driving large bloom shears, with actual load curves and full data of the machines tested.

No discussion.

THE INDUSTRIAL APPLICATION OF THE ELECTRIC MOTOR AS ILLUSTRATED IN THE GARY PLANT OF THE INDIANA STEEL COMPANY

B. R. Shover Vol. xxviii—1909, pp. 101-146

Description of electrical equipment of the Gary plant, with data on motor sizes and power required to operate steel-making machinery.

Discussion, pp. 147-161, by Messrs. B. A. Behrend, Gano Dunn, William T. Dean, Brent Wiley, Robert Hull, David B. Rushmore, Louis A. Ferguson, and B. R. Shover.

Additional data on and description of steel-making machinery. Design and operative features of large gas engines for parallel working.

FUNCTION OF FLY-WHEELS IN CONNECTION WITH ELECTRICALLY OPERATED ROLLING MILLS

H. C. Specht Vol. xxviii—1909, pp. 869-878

Theoretical analysis of the performance of induction motor rolling mill drive with varying amounts of fly-wheel effect. Numerical exam-

ples chosen to indicate the most economical combination for driving a given plate and rail mill.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

ROLLING MILL MOTORS

E. W. Yearsley Vol. xxviii—1909, pp. 879-880

General requirements of rolling mill motor equipment.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

ELECTRIC DRIVEN ROLLING MILLS

E. Friedlander Vol. xxviii—1909, pp. 881-887

General discussion of the advantages of electric drive in rolling mills.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

POWER REQUIREMENTS FOR ROLLING HIGH CARBON STEEL OF SMALL SECTION

Brent Wiley Vol. xxviii—1909, pp. 889-895

Description of tests made on a merchant mill, giving tabulated data and recording wattmeter charts. All-day record of rolling mill, giving output, operating time, lost time, energy consumption, friction load, etc.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

ELECTRIC CONTROL FOR ROLLING MILL MOTORS

C. F. Henderson Vol. xxviii—1909, pp. 897-912

Brief outline of essential requirements of controllers for motors operating ore handling machinery and rolling mills, with description of contactor type controller and various applications of automatic controllers in and about a steel mill.

Discussion, incorporated with that of Mr. R. Tschentscher's paper on "Electric Power Problems in Steel Plants."

ELECTRIC POWER PROBLEMS IN STEEL PLANTS

R. Tschentscher Vol. xxviii—1909, pp. 921-930

Classification of steel mills and brief general discussion of power requirements of each type, together with analytical discussion of the economic value of low-pressure steam turbines in utilizing waste heat and of over-excited synchronous converters in improving power-factor, the latter being developed with special reference to application in the South Chicago plant of the Illinois Steel Company.

Discussion, pp. 931-946, by Messrs. David B. Rushmore, Brent Wiley,

K. A. Pauly, M. O. Delplain, S. Lankton Clark, H. C. Specht, Charles F. Scott, John C. Reed, H. E. White, A. M. Dudley, H. K. English, Arthur C. Eastwood, and Arthur Simon.

General discussion of design, control and operation of induction motor drive for rolling mills. Calculation of fly-wheel capacity. Detailed description of control system used on Hulett ore unloader.

INTERACTION OF FLY-WHEELS AND MOTORS WHEN DRIVING ROLL TRAINS BY INDUCTION MOTORS

F. G. Gasche — Vol. xxix—1910, pp. 1385-1402

General discussion of the application of fly-wheels to roll mill drive, followed by mathematical analysis of the forces acting in an induction motor fly-wheel set when coupled to a roll train, with a full mathematical development of the equations.

Discussion, pp. 1403-1414, by Messrs. C. P. Steinmetz, C. F. Scott, Gano Dunn, Selby Haar, W. W. Crawford, and F. G. Gasche.

Short-cut methods of calculating the performance of fly-wheel induction motor drive for roll trains.

D. HEATING

NOTES ON THE ELECTRIC HEATING PLANT OF THE BILTMORE ESTATE

Chas. E. Waddell — Vol. xxvii—1908, pp. 651-666

Actual performance of large electric heating system for laundry, comparing this service with that of fuel-generated steam system, with respect to first cost of operation and convenience.

Discussion, pp. 667-668, by Messrs. Percy H. Thomas, Elmer A. Sperry, Charles E. Waddell, and John H. Finney.

Details of the electric steam generator and results of tests showing the fuel equivalent for one kilowatt hour.

ELECTRIC HEATING

W. S. Hadaway, Jr. — Vol. xxvii—1908, pp. 1585-1598

General discussion of the relative merits of electric energy and other forms of energy for operating a heat distribution system. Suggested plan for heating service in which electricity and steam are both used, one for general low-temperature heating and the other for high-temperature and localized heating.

Discussion, pp. 1599-1612, by Messrs. Charles E. Waddell, W. N. Ryerson, W. S. Andrews, H. P. Ball, Max Lowenthal, Charles P. Steinmetz, Townsend Wolcott, and W. S. Hadaway, Jr.

Storage of heat energy to improve load factor. Experience with electric heating of large buildings. Data on heating element design. Discussion of thermodynamic heating process.

E. MISCELLANEOUS

THE OPERATION OF MACHINE SHOPS BY INDIVIDUAL ELECTRIC MOTORS

R. T. E. Lozier Vol. xx—1902, pp. 115-126

Load factor in machine shop practice and its effect on economy of various methods of supplying motive power. Review of electrical methods of speed control, going over respective limitations. Advantages of individual motor drive in high efficiency shop operation.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous Current Motors for Machine Tools."

THE STORAGE BATTERY AS A FACTOR IN SPEED CONTROL

H. P. Coho Vol. xx—1902, pp. 135-138

Brief description of electric drive for Hoe printing press, using storage battery for multi-voltage.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous-Current Motors for Machine Tools."

ELECTRICALLY OPERATED COAL HOIST HAVING VARIABLE SPEED CONTROL

P. H. Keilholtz Vol. xx—1902, pp. 139-142

Brief discussion of electric coal hoist equipped with Ward-Leonard system of speed control. Tests of power required, speed-time curves and other operative data.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous-Current Motors for Machine Tools."

A SERIES-PARALLEL SYSTEM OF SPEED CONTROL

Geo. W. Fowler Vol. xx—1902, pp. 143-153

Description of controller and its mode of operation as applied to double commutator motor driving webb press.

Discussion, incorporated with that of paper by F. O. Blackwell on "Continuous-Current Motors for Machine Tools."

CONTINUOUS CURRENT MOTORS FOR MACHINE TOOLS

F. O. Blackwell Vol. xx—1902, pp. 159-165

Power characteristics and requirements of various classes of machine tools. Brief mention of the different methods of speed control of electric motors and the advantages and limitations of each.

Discussion (including that of paper by R. T. E. Lozier on "The Operation of Machine Shops by Individual Electric Motors;" paper by N. W. Storer on "Three-Wire System for Variable Speed Motor Work;" paper by H. B. Coho on "The Storage Battery as a Factor in Speed Control;" paper by P. O. Keilholtz on "Electrically Operated Coal Hoist Having Variable Speed Control;" paper by George W. Fowler on "A Series-Parallel System of Speed Control," and paper by H. Ward Leonard on "Multiple Unit, Voltage Speed Control for Trunk Line Service"), pp.

166-195, by Messrs. Gano S. Dunn, Charles F. Scott, H. E. Heath, S. T. Dodd, Arthur Williams, Philip Lange, Charles Day, R. T. E. Lozier, N. W. Storer, H. Ward Leonard, Herbert Dowe, H. B. Coho, George A. Damon, R. W. Stovel, George B. Dusinberre, W. A. Dick, P. M. Lincoln, —— Campbell, Charles G. Winslow, E. M. Tingley, —— Stevenson, —— Barr, R. H. Pierce, Peter Junkersfeld, O. E. Osthoff, D. C. Jackson, B. J. Arnold, G. B. Foster, Ernest Gonzenbach, V. R. Lansingh, Harry H. Cutler, F. J. Pearson, and H. R. King.

Relative merits of various methods of speed control of direct-current motors. Conditions which determine the choice between individual and group drive. Effects of motor drive and suitable speed control on shop efficiency. Advantages and disadvantages of the Ward-Leonard system of locomotive driven from single-phase circuits.

METHODS OF SPEED CONTROL

Wm. Cooper — **Vol. xx—1902, pp. 197-213**

Outline of the general power requirements of the different classes of machine tools. Description of method of choosing proper size of motor for given service and speed range from a speed-horse-power diagram for combining multiple voltage and field regulation; numerical examples. Set of general rules for determining motor size.

No discussion.

POWER CONSUMPTION OF ELEVATORS OPERATED BY ALTERNATING AND DIRECT-CURRENT MOTORS

Geo. F. Sever — **Vol. xix—1902, pp. 429-434**

Records of tests on the comparative performances of direct-current and alternating-current motors in elevator service.

Discussion, incorporated with that of paper by Charles M. Clark on "Telpherage."

ELECTRIC MOTORS FOR CENTRIFUGAL PUMPS AND FANS

August J. Bowie, Jr. — **Vol. xxii—1903, pp. 649-655**

Power requirements and characteristics of centrifugal pumps under various conditions of operation.

Discussion, pp. 656, by Messrs. H. G. Stott, and F. O. Blackwell.

THE REQUIREMENTS FOR AN INDUCTION MOTOR FROM THE USER'S POINT OF VIEW

Walter B. Nye — **Vol. xxix—1910, pp. 147-149**

Brief mention of some of the conditions which must be met in the design of coils, bearings, shafts, pulleys and controllers so as to improve continuity of service and facilitate repairs.

Discussion, including that of paper by Mr. Dugald C. Jackson on "The Applicability of Electrical Power to Industrial Establishments;"

Mr. Charles T. Main's paper on "Central Stations *Versus* Isolated Plants for Textile Mills;" Mr. R. S. Hale's paper on "The Supply of Electrical Power for Industrial Establishments from Central Stations," and Mr. G. H. Stickney's paper on "Illumination for Industrial Plants"—pp. 150-182, by Messrs. J. C. Parker, Charles B. Burleigh, Norman T. Wilcox, H. B. Emerson, N. W. Dalton, H. W. Peck, R. D. DeWolf, Albert L. Pearson, H. D. James, C. A. Graves, J. H. Gardiner, and H. D. Jackson.

General discussion of the relative advantages and disadvantages of central station and private plant energy supply, together with figures and experience from actual practice. Brief description of decentralized system of electrical energy production in which moderate size non-condensing turbo-electric stations supply both electricity and steam to consumers, the stations being inter-connected both by the electric and the steam distribution systems.

ELECTRIC POWER IN THE CONSTRUCTION OF THE LOS ANGELES AQUEDUCT

E. F. Scattergood — Vol. xxix—1910, pp. 361-373

Description of the power plant and electrical equipment for the construction of a very long (240 miles) aqueduct, including power plant; transmission line and description of generating machinery; power shovels, dredges and locomotives. Costs of power plant and equipment.

No discussion.

ELECTRIC DRIVE IN TEXTILE MILLS

Alber Milmow — Vol. xxix—1910, pp. 385-422

Analytical discussion of electric drive of textile mills with energy purchased from water-power companies, comparing electric with steam operation as to first cost, cost of operation, and effect on production. The study includes a series of 50 recording tachometer records, showing the importance of close speed regulation and the effect of electric drive thereon.

Discussion, pp. 423-427, by Messrs. Albert Milmow, Charles F. Scott, W. S. Lee, A. W. Henshaw, David B. Rushmore, and L. T. Robinson.

General remarks and further information bearing on the effect of speed variations on production.

MOTOR APPLICATION TO MACHINE TOOLS

Charles Fair — Vol. xxix—1910, pp. 621-647

Profusely illustrated discussion of the general principles underlying the application of motors to machine tools, with special reference to the choice and installation of apparatus for various kinds of machines.

No discussion.

HYDROELECTRIC POWER AS APPLIED TO IRRIGATION

John Coffee Hays Vol. xxix—1910, pp. 731-753

Description of a large ground water system of irrigation (Mount Whiting Power Company in California) operated with hydro-electric energy, covering the power equipment; forms of contracts and charges; load characteristics; power requirements for different classes of work, and effect of irrigation on land values.

Discussion, pp. 754-764, by Messrs. L. B. Stillwell, E. W. Paul, J. C. Hays, F. V. Henshaw, H. Homberger, L. Jorgensen, Ralph W. Pope, Markham Cheever, A. J. Bowie, Jr., W. A. Doble, and F. G. Baum.

General discussion of the relative advantages of construction having limited life and construction which is practically permanent, also general remarks on irrigation.

21. TELEPHONY AND TELEGRAPHY

A. GENERAL THEORY

INDUCTIVE DISTURBANCES IN TELEPHONE LINES

Louis Cohen — Vol. xxvi—1907 pp. 1155-1167

Mathematical development of general equations for calculating the effects of electromagnetic induction, followed by equations for the special case of two parallel telephone circuits.

No discussion.

TELEGRAPH AND TELEPHONE SYSTEMS AS AFFECTED BY ALTERNATING-CURRENT LINES

John B. Taylor — Vol. xxviii—1909, pp. 1169-1215

Theoretical and experimental investigation of electrostatic and electromagnetic disturbances caused in various types of telephone and telegraph systems by different kinds of alternating-current transmission and distribution systems.

Discussion, pp. 1216-1252, by Messrs. L. B. Stillwell, Charles F. Scott, A. W. Copely, W. S. Murray, Charles P. Steinmetz, L. C. Nicholson, J. C. Barclay, A. L. Cook, Frank F. Fowle, and A. S. Richey.

Experience in operation of telephone and telegraph lines paralleling high-tension transmission lines and single-phase railways, and results obtained with neutralizing apparatus.

B. TELEPHONE SYSTEMS

ELECTRICITY IN THE SIGNAL CORPS

Lieut. Col. Samuel Reber — Vol. xix—1902, pp. 707-724

Scope of the duties of the Army Signal Corps. Telegraph and telephone construction in the field and in fortresses. Detailed description of signal apparatus used in the army.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

THE TELEPHONE SWITCHBOARD

Chas. F. Scott — Vol. xxi—1903, pp. 1-2

THE EVOLUTION OF THE TELEPHONE SWITCHBOARD.

William D. Lockwood — Vol. xxi, 1903, pp. 3-30

Historical outline of the development of the standard relay switchboard, with description of the circuits and mode of operation at different stages of development from 1877 to date.

Discussion, incorporated with that of paper by William J. Hammer on "An Automatic Telephone Operator."

AN AUTOMATIC TELEPHONE OPERATOR

William J. Hammer — Vol. xxi—1903, pp. 31-54

Description of Connolly & McTighe automatic telephone system, comparing the apparatus and mode of operation with the manual system.

Discussion (including that of paper by William D. Lockwood on "The Evolution of the Telephone Switchboard"), pp. 55-71 and 84-92, by Messrs. Charles F. Scott, William D. Lockwood, Samuel Sheldon, J. J. Carty, F. A. Pickernell, Bancroft Gherardi, E. F. Sherwood, G. C. Allen, F. E. Kinsman, S. P. Grace, Charles Bradley, P. M. Lincoln, L. J. Gallagher, and L. Homiwel.

General remarks on manual telephone exchange operation-service quality tests in New York; functions of telephone system compared with those of electric light plant; instruction of telephone operators; wire plant operation. Advantages of common battery over magneto telephone system Simplification of standard relay board.

SOME FEATURES OF TELEPHONE TRAFFIC AND THEIR EFFECT ON SERVICE

J. G. Wray — Vol. xxi—1903, pp. 73-80

Outline of the factors essential to good telephone service. Part played by the subscriber in determining quality of service, analysis of the traffic load curve in Chicago and other large cities. Efficiency of telephone plant.

No discussion.

CONCERNING THE TELEPHONE ENGINEER

S. G. McMeen — Vol. xxi—1903, pp. 81-83

THE ARCOPHONE

R. A. L. Snyder — Vol. xxi—1903, pp. 93-95

Brief description of the development and theory of the speaking arc, with experimental demonstration.

No discussion.

TELEPHONE ENGINEERING

J. J. Carty — Vol. xxv—1906, pp. 81-105

Description of functions of telephone engineer. Character and scope of telephone engineering. General outline of methods of telephone plant development in large city. Relation of commercial policy to telephone engineering.

Discussion, pp. 106-112, by Messrs. Thomas D. Lockwood, S. S. Wheeler, Bancroft Gherardi, and C. P. Steinmetz.

Some features of early telephone plant operation. Functions of traffic engineer.

UNDERGROUND TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY

Charles E. Phelps — Vol. xxvi—1907, pp. 25-30

Classification of cable faults, followed by seven-year record of the performance of various kinds of power, telephone and telegraph cables. Brief analytical discussion of the causes and remedies for these various faults.

No discussion.

THE TELEPHONE WIRE PLANT

Sergius P. Grace — Vol. xxvi—1907, pp. 569-595

General remarks on method of laying out telephone wire plant so as to serve a growing community in the most efficient and economical manner. Details and sketch of cable terminals, wire fastenings, pole tops, etc.

Discussion, pp. 596-603, by Messrs. John J. Carty, Hammond V. Hayes, G. M. Yorke, F. L. Gilman, and Kempster B. Miller.

Extent of wire plant of New York Telephone Company. Stages of cable development that led up to lead covered paper insulated cable.

A STUDY OF MULTI-OFFICE AUTOMATIC SWITCHBOARD TELEPHONE SYSTEMS

W. Lee Campbell — Vol. xxvii—1908, pp. 503-541

Comparative study of the automatic and the manual telephone systems, with respect to cost, flexibility, wire efficiency, maintenance, depreciation and business expansion.

Discussion, pp. 542-551, by Messrs. A. B. Smith, John Wicks, E. A. Mellinger, Morgan Brooks, L. E. Hurtz, Samuel G. McMeen, and W. Lee Campbell.

General remarks on the multi-office system for both manual and automatic telephones. Data and experience from practice with automatic sub-stations without attendants.

METHODS FOR LOCATING TRANSPOSITIONS OF WIRES AND SPLIT PAIRS IN TELEPHONE AND TELEGRAPH CIRCUITS

Henry W. Fisher — Vol. xxvii—1908, pp. 1721-1732

Derivation of capacity formulas for locating faults due to transposition of wires. Comparison of results of tests using these formulas with actual distances.

No discussion.

THE MODERN TELEPHONE CABLE

Frank B. Jewett — Vol. xxviii—1909, pp. 1079-1093

Outline of essential requirements of telephone cables as to general construction, materials, and electrical and mechanical properties.

No discussion.

A MODERN AUTOMATIC TELEPHONE APPARATUS

W. Lee Campbell Vol. xxix—1910 pp. 55-84

Description of the construction and mode of operation of the Strowger automatic telephone system.

Discussion, pp. 85-106, by Messrs. William Maver, Ralph W. Pope, E. A. Mellinger, E. L. Lehman, Charles A. LeQuesne, Jr., A. R. Sawyer, L. C. Tomlinson, H. A. Robbins, and W. Lee Campbell.

General discussion of the operative characteristics of automatic telephony, including data on cost of maintenance and depreciation.

THE AUTOMATIC TELEPHONE IN RELATION TO CITY SERVICE

Arthur Bessey Smith Vol. xxix—1910 pp. 1357-1378

Description of the general features of the San Francisco & Oakland automatic telephone system from the operating standpoint, with special reference to rapid-fire suburban toll service, with method of checking back; metered and pre-payment service, and inter-connection of two-wire and three-wire exchanges.

Discussion, pp. 1379-1384, by Messrs. Frank F. Fowle, George D. Shepardson, L. M. Antoine, and A. B. Smith.

General remarks on the advantages of the automatic telephone system.

C. TELEGRAPH SYSTEMS

A NEW PAGE PRINTING TELEGRAPH

William B. Vansize Vol. xviii—1901, pp. 7-29

Brief mention of men that have contributed to the development of printing telegraphy. Detailed description of the Murray page printer. Construction fully illustrated.

Discussion, pp. 30-43, by Messrs. George T. Hanchett, William B. Vansize, Carl Hering, F. B. Herzog, F. V. Henshaw, A. C. Crehore, Hollon C. Spaulding, William Mawer, Jr., Donald Murray, and Francis W. Jones.

Additional data on operation of the Murray printer.

ELECTRICITY IN THE SIGNAL CORPS

Lieut. Col. Samuel Reber Vol. xix—1902, pp. 707-724

Scope of the duties of the Army Signal Corps. Telegraph and telephone construction in the field and in fortresses. Detailed description of signal apparatus used in the army.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

THE TELAUTOGRAPH

James Dixon Vol. xxiii—1904, pp. 645-655

Description of the development, construction, operation and application of the Gray writing telegraph.

Discussion, pp. 656-657, by Messrs. F. C. Bates, C. O. Mailloux, James Dixon, E. B. Fahnestock, A. C. Crehore, and Townsend Wolcott.

Operation of telautograph—limiting distance, effect of line leakage and mechanical vibration.

UNDERGROUND TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY

Charles E. Phelps Vol. xxvi—1907 pp. 25-30

Classification of cable faults, followed by seven-year record of the performance of various kinds of power, telephone and telegraph cables. Brief analytical discussion of the causes and remedies for these various faults.

No discussion.

THE ROWLAND TELEGRAPHIC SYSTEM

Louis M. Potts Vol. xxvi—1907, pp. 507-538

Description of the theory of operation, construction and practical application of the Rowland printing telegraph.

Discussion, pp. 539-554, by Messrs. Ralph W. Pope, A. E. Kennelly, William Maver, Jr., Henry G. Stott, E. F. Northrup, Gano Dunn, and Sir William Preece.

Early experiences in the telegraph field and reminiscences of Rowland, Edison and Faraday.

AMERICAN TELEGRAPH ENGINEERING—NOTES ON HISTORY AND PRACTICE

William Maver, Jr. and Donald McNicol Vol. xxix—1910, pp. 1303-1338

Brief historical résumé of American telegraph practice, followed by short discussion of some of the most salient features of present day practice, such as: Sources of e. m. f.; printers; super-imposed systems; inductive disturbances; testing; aerial *vs.* underground lines. Suggested plan for housing in telegraph lines for protection from storms.

Discussion, pp. 1339-1356, by Messrs. William Maver, Jr., Ralph W. Pope, John B. Taylor, Gano Dunn, William B. Hale, G. A. Cellar, Louis M. Potts, W. J. Camp, F. W. Jones, Donald McNicol, and Charles F. Scott.

Remarks on telegraph practice in United States, Mexico and Europe. Opinions as to the requirements of the ideal telegraph system.

D. WIRELESS SYSTEMS

ANNUAL DINNER OF AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Guest of Honor, Guglielmo Marconi Vol. xix—1902, pp. 93-121

Description of the present status of achievement with Marconi system. Evolution of the wireless from wire telegraph system explained with the help of diagrams.

WIRELESS TELEGRAPHY IN THE UNITED STATES NAVY

Lieut. A. M. Beecher Vol. xix-1902, pp. 569-578

Description of the general principles of wireless telegraph systems and account of what has actually been done in the navy.

Discussion, incorporated with that of paper by Louis Bell on "Emergency Engineering for Harbor Defence."

THE AUDION

Lee DeForrest Vol. xxv—1906, pp. 735-736

Account of the inception and development of vacuum tube hot-electrode wave detector and theoretical discussion of the conduction of electricity through heated vapors and gases, with much experimental data and frequent references to the work of others.

Discussion, pp. 764-779, by Messrs. Michael I. Pupin, Percy H. Thomas, Lee DeForrest, Sewall Cabot, J. B. Taylor, Edward P. Thompson, Frederick K. Vreeland, C. D. Ehret, W. E. S. Temple, H. C. Snook, E. F. Northrup, James Haywood, and George Breed.

Hittorf's discovery of the effect on conduction through gases in vacuum tube of heating the electrode. Nature of ions and corpuscles. Explanation of operation of audion by accoustical theory. Analogy between audion and polariphone (electrolytic wave detector). Difference between Fleming rectifier and audion.

WIRELESS TELEGRAPH RECEIVERS

S. M. Kintner Vol. xxv—1906, pp. 781-787

General remarks on wave detectors invented by Professor Fessenden —hot wire and liquid barretters.

No discussion.

WIRELESS TELEPHONY

R. A. Fessenden Vol. xxvii—1908, pp. 553-629

Brief history of the development of wireless signalling with numerous references to the original documents. Account of author's invention of wireless telephony and subsequent work. Short description of the different types of wireless telephone apparatus. Results of experiments on atmospheric absorption of waves, together with forecast of future of wireless telephony. Long account of how wireless telegraph has been hampered by governmental action. Numerous quotations.

No discussion.

22. MISCELLANEOUS TOPICS

A. INSTITUTE AFFAIRS

ANNUAL REPORTS

Vol. xviii—1901, pp. 207-218
Vol. xix—1902, pp. 487-497
Vol. xxi—1903, pp. 479-486
Vol. xxiii—1904, pp. 807-838
Vol. xxiv—1903, pp. 1120-1151
Vol. xxv—1906, pp. 927-943
Vol. xxvi—1907, pp. 891-909
Vol. xxvii—1908, pp. 1743-1761
Vol. xxviii—1909, pp. 1503-1520
Vol. xxix—1910, pp. 1730-1747

PRESIDENTIAL ADDRESSES

Charles P. Steinmetz Vol. xix—1902, pp. 1145-1150

Description of the shortcomings in present methods of teaching engineering in colleges. Outline of an ideal course in electrical engineering.

Discussion, incorporated with that of paper by E. B. Raymond on "Proposed Reform in Technical Training."

Charles F. Scott Vol. xxii—1903, pp. 3-15

Brief discussion of the status of the Institute. The age and occupation of its members. An outline of plans for the development of the usefulness of the Institute, and definite proposal for carrying out this work of development.

No discussion.

Bion J. Arnold Vol. xxiii—1904, pp. 615-623

Brief sketch of electric railway development since 1893. Present prospects of electric locomotives supplanting steam locomotives. Dividing line between steam and electric trunk line operation.

Discussion, pp. 624-644, by Messrs. Charles P. Steinmetz, ——— Gray, John Perry, B. G. Lamme, C. V. Drysdale, B. J. Arnold, F. J. Sprague, and Elihu Thomson.

The requirements of different classes of railway service—city, suburban, and interurban passenger and freight trunk line, and mountain service. Speed torque characteristics of various types of railway motors, single-phase, polyphase and direct-current, and discussion of their proper spheres of application. Development and application of single-phase compensated series motor. Methods of control. Invention of the repulsion motor.

PRESIDENTIAL ADDRESSES—(*Continued*)

John W. Lieb, Jr. Vol. xxiv—1905, pp. 283-286

General review of the practices of the National Engineering Societies of the United States and Europe, with special reference to requirements for membership, expenses and disbursements per member, administration, standing committees, local branch organizations, etc.

No discussion.

Schuyler Skatts Wheeler Vol. xxv—1906, pp. 241-266

General outline of moral duties of electrical engineers. Abstract of codes of ethics in various professions—ministry, law, medicine, architecture and engineering.

Discussion, pp. 266-268, by Messrs. C. P. Steinmetz, Dugald C. Jackson, S. S. Wheeler, and C. F. Scott.

Motion made and passed to nominate committee to consider drafting of code of ethics.

Samuel Sheldon Vol. xxvi—1907, pp. 937-968

Conception of electrons and brief exposition of their properties. Application of electronic theory to the explanation of the fundamental principles of electrophysics—conduction of electricity in gases, vapors and solids; contact, thermal and electromagnetic generation of e. m. f., dielectric phenomena; radiation and luminescence.

No discussion.

Henry Gordon Stott Vol. xxvii—1908, pp. 459-464

Definition of engineering. The part that the engineer should play in public life.

No discussion.

Louis A. Ferguson Vol. xxviii—1909, pp. 355-361

Fnancial, technical and industrial advantages of centralization of electrical energy production.

No discussion.

Lewis B. Stillwell Vol. xxix—1910, pp. 1037-1052

Discussion and criticism of Government's water power conservation policy, with suggested plan of water power control.

No discussion.

MISCELLANEOUS AFFAIRS

REPORT OF THE COMMITTEE ON STANDARDIZATION

Vol. xix—1902, pp. 1075-1091

Discussion, p. 1092, by Messrs. Chas. P. Steinmetz, F. A. C. Perrine and William Stanley.

PROPOSED DEVELOPMENT OF THE INSTITUTE

Chas. F. Scott — Vol. xx—1902, pp. 1-14

Outline of the functions of the Institute and brief description of the plans for future development.

No discussion.

LIBRARY DINNER OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Vol. xxi—1903, pp. 97-108

Speeches by Messrs. Chas. F. Scott, T. C. Martin, S. S. Wheeler, Andrew Carnegie, J. S. Billings, R. R. Bowker, Theodore L. DeVinne, and Jas. C. Bayles.

ENGINEERING SOCIETIES' BUILDINGS

Vol. xxi—1903, pp. 479-496

Annual report of Board of Directors and resolutions in regard to Engineering Societies' Building.

INSTITUTE BRANCH MEETINGS. THEIR ORGANIZATION, DEVELOPMENT AND INFLUENCE

Calvin W. Rice — Vol. xxii—1903, pp. 63-66

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Samuel Sheldon — Vol. xxv—1906, pp. 661-669

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No discussion.

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B. CONSERVATION OF NATURAL RESOURCES

THE PRESERVATION OF THE SOUTHERN APPALACHIAN STREAMS. A FOREST PROBLEM

Charles Edward Waddell — Vol. xxiv—1905, pp. 889-892

Brief characterization of the water shed. Extent of erosion due to floods. Action of forests in stream preservation.

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CONSERVATION OF POWER RESOURCES

H. St. Clair Putnam — Vol. xxvii—1908, pp. 377-396

Statistical study of the natural sources of energy in the United States and their utilization, showing their extent, value and method of use.

No discussion.

WATER POWER DEVELOPMENT IN THE NATIONAL FORESTS. A SUGGESTED GOVERNMENT POLICY

Frank G. Baum — Vol. xxvii—1908, pp. 475-484

A plan for controlling the development of water power and a method of fixing and utilizing the conservation charges.

Discussion, pp. 405-502, by Messrs. J. H. Finney, E. R. Taylor, T. P. Wells, A. H. Babcock, H. G. Stott, C. P. Steinmetz, William McClellan, C H. Porter, and J. A. Britton.

Criticisms of Mr. Baum's plan. Outline of the Forest Service policy and general discussion of the problem of conservation of water power as a national asset.

ELECTRICITY AND THE CONSERVATION OF ENERGY

Lewis B. Stillwell — Vol. xxviii—1909, pp. 163-178

Analytical discussion of the problem of conserving natural resources, with special reference to the part played by water power companies and central electric stations. Statistics.

Discussion, pp. 179-187, by Mr. John Coffee Hays.

Water power rights and conservation of natural resources in California. Suggested control of Government water power grants.

CONSERVATION OF WATER POWERS

Lewis B. Stillwell — Vol. xxix—1910, pp. 1037-1052

Discussion and criticism of Government's water power conservation policy, with suggested plan of water power control.

No discussion.

C. GENERAL SUBJECTS

IMPORTANT EUROPEAN ELECTRICAL AND ENGINEERING DEVELOPMENTS AT THE CLOSE OF THE NINETEENTH CENTURY

William J. Hammer — Vol. xviii—1901, pp. 47-122

General description of Poulsen's Telephonograph; Engen-Langen suspended monorail railway; Nernst lamps, Osmium lamps; gas engines for blast furnace gas and producer gas; sulphur dioxide or binary engine; trackless trolley bus; electric plough; experimental three-phase railways at Alte-Ofen and at Grosse Lichterfelde; Jungfrau railway.

No discussion.

COLLOIDS

W. R. Whitney **Vol. xix—1902, pp. 343-352**

Comparison of the characteristics of colloidal and ordinary solutions. Discussion of the theory of colloidal precipitation and other properties of colloids.

Discussion (including that of paper by Samuel Sheldon on "The Electro-Chemical Industries;" paper by Chas. B. Jacobs on "The Electric Furnace in Industrial Chemistry;" paper by Carl Hering on "The Electrolytic Conduction without Electrodes;" paper by Carl Hering on "Liquid Potentiometer; Determining Electrolytic Resistances with Direct-Current Instruments;" paper by Carl Hering on "Point of Cutoff in a Battery Discharge;" and paper by N. S. Keith on "Electrolytic Recovery of Copper from Low-Grade Ores"), pp. 351-372, by Messrs. C. P. Steinmetz, Maurice LeBlanc, Chas. S. Bradley, C. A. Doremus, N. S. Keith, W. R. Whitney, Edward P. Thompson, C. J. Reed, Carl Hering, Samuel Sheldon, Chas. B. Jacobs, and C. F. Burgess.

General discussion of the theory of colloids from both electrical and mechanical viewpoints. Application of the theory of evolution to development of an electro-chemical process.

THE ENGINEER OF THE TWENTIETH CENTURY

Chas. F. Scott **Vol. xx—1902, pp. 301-306**

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RADIOACTIVE SUBSTANCES

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Introduction by President Chas. F. Scott.

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATION OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRAVIOLET LIGHT

William J. Hammer **Vol. xxi—1903, pp. 331-402**

General discourse on luminous and chemical radiations and some practical applications of these forms of energy. Historical notes on the development of the various branches of these sciences and short description of much of the original work.

No discussion.

THE ART OF INVENTING

Edwin J. Prindle **Vol. xxv—1906, pp. 519-541**

Inventing as a profession; classification of inventions; examples of mode of procedure in evolving certain inventions.

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DEFLOCCULATED GRAPHITE

Edward G. Acheson Vol. xxvi—1907, pp. 1363-1366

Brief description of the development of a process of producing deflocculated graphite which will remain suspended in water or oil indefinitely.

No discussion.

THE ENGINEER'S ACTIVITY IN PUBLIC AFFAIRS PUBLIC UTILITY COMMISSION AND FRANCHISE VALUATIONS

Henry Floy Vol. xxvii—1908, pp. 335-353

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General remarks on Public Service Commissions—franchise valuation "fair return" on investment.

THE EVOLUTION OF ENGINEERING
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Henry Gordon Stott Vol. xxvii—1908, pp. 459-464

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No discussion.

ELECTRICITY AS VIEWED BY THE INSURANCE ENGINEER; SHOULD THE A. I. E. E. INTEREST ITSELF IN FIRE PROTECTION

C. M. Goddard Vol. xxvii—1908, pp. 467-472

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THE PATENT SYSTEM AND ITS RELATION TO INDUSTRIAL DEVELOPMENT

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